

Jordan and Associates

AF88-092 Phase I

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SBIR PROJECT AF88-092 PHASE I

SYSTEMS LEVEL TECHNOLOGY ASSESSMENT METHODOLOGY
FOR STOVL TYPE AIRCRAFT

FINAL REPORT

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94-01346



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REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS	
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION/AVAILABILITY OF REPORT UNLIMITED	
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE			
4. PERFORMING ORGANIZATION REPORT NUMBER(S) JOR 88-01		5. MONITORING ORGANIZATION REPORT NUMBER(S)	
6a. NAME OF PERFORMING ORGANIZATION JORDAN AND ASSOCIATES	6b. OFFICE SYMBOL (If applicable) AFWAL/TXAA	7a. NAME OF MONITORING ORGANIZATION AFWAL/TXAA	
6c. ADDRESS (City, State, and ZIP Code) P. O. BOX 22605 KNOXVILLE, TN 37933-0605		7b. ADDRESS (City, State, and ZIP Code) WRIGHT-PATTERSON AFB OHIO 45433-6553	
8a. NAME OF FUNDING/SPONSORING ORGANIZATION TECHNOLOGY EXPLOITATION DIR	8b. OFFICE SYMBOL (If applicable) AFWAL/TXAA	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER F33615-88-C-3800	
10c. ADDRESS (City, State, and ZIP Code) WRIGHT-PATTERSON AFB OHIO 45433-6553		10. SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO. 65502F	PROJECT NO.
		TASK NO.	WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) SYSTEMS LEVEL TECHNOLOGY ASSESSMENT METHODOLOGY FOR STOVL TYPE AIRCRAFT VOLUME II: BIBLIOGRAPHY (U)			
12. PERSONAL AUTHOR(S) MICHAEL F. JORDAN			
13a. TYPE OF REPORT FINAL REPORT	13b. TIME COVERED FROM JUL 88 TO DEC 88	14. DATE OF REPORT (Year, Month, Day) 1988 DECEMBER 23	15. PAGE COUNT
16. SUPPLEMENTARY NOTATION			
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	SIMULATION COMPUTER MODELS WAR GAMING BIBLIOGRAPHY
19. ABSTRACT (Continue on reverse if necessary and identify by block number)			
<p>The purpose of this Small Business Innovation Research (SBIR) Program was to conduct a survey of possible systems level technology assessment approaches and to recommend a suitable technique and approach for a Phase II methodology development activity. The survey consisted of the review of several thousands of existing computer simulation models and methodologies for applicability to systems level technology assessment. The models were categorized according to purpose and scope. A bibliography of relevant models was created, including an annotated bibliography of a subset of the overall bibliography. Several models most nearly suited to the task of systems level technology assessment were then evaluated for their applicability to TXAA requirements. The result was the recommendation that a new simulation model be created.</p>			
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL JOHN M. BYRNES		22b. TELEPHONE (Include Area Code) 513-255-5000 4843	22c. OFFICE SYMBOL AFWAL/TXAA WL/XPR

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DD Form 1473

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Accession For	
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DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
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PREFACE

This bibliography is organized according to model category. The categories are:

1. Global Models. These are models that consider both the operational effectiveness and the operational suitability of a weapon system. The models simulate the performance of the system in general operations and in interactive combat operations. In other words, the models are concerned with the total spectrum of operational possibilities.

2. Specific Interaction Models. These models are concerned with a specific aspect of the performance of a system as it interacts with some other system. For example, a model that investigates the dogfight capability of an aircraft with an adversary would be included in this category.

3. System/Subsystem Performance Models. This category includes models that simulate the general performance of a specific system or subsystem. An example would be a model of a landing gear system for an aircraft.

4. Reliability - Maintainability - Supportability - Logistic - Life Cycle Cost Models. These models focus upon those aspects of a system that are not related to operational effectiveness. Maintenance, supply, logistics, and cost models are included in this category.

5. Models and Topics of General Interest. This category includes models and concepts that are not specifically associated with tactical aircraft but are interesting because of their purpose or unique character.

6. Comparisons and Bibliographies. This category includes reports that make comparisons of various models, bibliographies, and compendiums of models.

Section 1 of this document is the general bibliography of all documents and models surveyed in this study effort.

Section 2 is an annotated bibliography of selected entries from the general bibliography.

Section 3 contains a listing of the acronyms used in the general bibliography. These represent the various developers and sponsors for the models included herein.

SECTION I
GENERAL BIBLIOGRAPHY

Entries to this bibliography have the following format:

Entry Code

AD Number STAR Number DLSIE Number Agency Report Number

Title of Document. Name of Author. Date of Publication.

Organization of Author. (Sponsoring Organization; Contract Number)

Volume Titles (if applicable)

The Entry Code is provided for reference in other sections of this report. An * next to the Entry Code indicates the report or model is described in Section 2, Annotated Bibliography.

The AD Number is the Defense Technical Information Center (DTIC) document acquisition number.

The STAR Number is assigned when the document is listed in the Scientific and Technical Aerospace Reports bibliography.

The DLSIE Number is the Defense Logistics Studies Information Exchange document number.

The Agency Report Number is assigned by the authoring organization, sponsoring organization, or both.

Absence of a particular entry in the listing indicates that the information was not available.

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GLOBAL MODELS

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The Entry No(s) refer to the applicable documents in the General Bibliography.

Jordan and Associates

AF88-092 Phase I

GLOBAL MODELS

<u>Acronym</u>	<u>Name</u>
ALBS	Air Land Battle Simulation
ATLAS	A Tactical, Logistical, and Air Simulation
DETEC	Defense Technology Evaluation Code
FAST STICK	
HACES	Helicopter Air Combat Effectiveness Simulation
INBATIM	Integrated Battlefield Interactive Model
JTLS	Joint Theater Level Simulation
MTOM	Mission Trade-off Methodology
MULTIX	Multiple Impact Examination
NAVMOD	Navy Model
OPTSA	Optimal Sortie Allocation
SGM	Sortie Generation Model
SORTY30	
TAC THUNDER	
TAC WARRIOR	
TRACE	Tactical Resources and Combat Effectiveness
TSAR	Theater Simulation of Airbase Resources
TWX	Theater War Exercise

CATEGORY: 1

ACRONYM: ALBS

NAME: Air Land Battle Simulation

PURPOSE: To compare the effectiveness of different doctrines, weapons, C2 systems, and rules of engagement.

ENTRY No(s): 1-1

MODEL DATA: Fortran and C language; VAX/780

DESCRIPTION: ALBS is a deterministic model of Air-Land Battle 2000 concepts that may be played in several modes:
- One player versus the computerized opponent
- One player assisted by computerized expert advice against the computerized opponent
- Two players with or without computerized expert advice.

The model will simulate engagements up to division on division sized units and down to battalion task forces, one 100 x 100 km region at a time. At present, only weapons data for NATO versus Warsaw Pact is included.

Expert knowledge regarding friendly and enemy capabilities and intentions is input into a readable, traceable, and modifiable knowledge base. Unit orders are expressed in a hierarchy of goals and subgoals. Candidate unit deployments, control measures and maneuvers are input via a digitizer or directly from SITREP. Topographical data are derived from the DMA elevation and feature data base or from digitized tactical maps. Weapons effects data also are entered.

Output includes: animated maneuvers, bar charts, statistics, raw data, and friendly and enemy measures of effectiveness based on degree of fulfillment of mission specific goals and subgoals.

CATEGORY: 1

ACRONYM: ATLAS

NAME: A Tactical, Logistical, and Air Simulation

PURPOSE: To simulate conventional theater level combat operations over an extended period.

ENTRY No(s): 1-2

MODEL DATA: Fortran; UNIVAC 1100 series

DESCRIPTION: ATLAS is a two-sided, deterministic model involving land and air forces. It was primarily designed to consider division level ground forces and aircraft by mission. The model may be manipulated, however, to consider units down to the brigade or battalion level.

The model considers combat operations by "sector." Each sector is designed to represent a corps level force. Up to 10 sectors (corps) can be simulated in a representation of theater level combat. Time is treated in increments of 24 hours.

The daily movement of a FEBA is developed as a function of firepower, terrain, posture, residual personnel strengths, and logistic support. The model considers the scheduling of reinforcements and logistic capability of lines of communication.

Battle assessments are dependent on the ratios of the opposing forces computed from firepower scores. Index of Combat Effectiveness (ICE) values are modified by casualties or lack of supplies to form a net ICE. Weapon firepower effects are treated as linearly additive with no adjustment for training, morale, combined arms, or command and control.

Input includes environmental data; ground forces; supply requirements and their constraints; and performance, vulnerability, and other data on aircraft, airbases, and SAM sites.

Output consists of computer printout of the daily status of forces, specific days or submodels, or a comprehensive theater summary. The results are expressed as average expected values, derived deterministically.

CATEGORY:

I

ACRONYM:

DETEC

NAME:

DEFense Technology Evaluation Code

PURPOSE:

To assess the potential of a realistically diverse assortment of strategic defensive and offensive assets deployed on all sides in a possible global conflict.

ENTRY No(s):

1-3

MODEL DATA:

Fortran; CRAY-X

DESCRIPTION:

DETEC is an automated, discrete object simulation. All combatants may have defensive and offensive assets, each of which may have a separate modular representation at several levels of fidelity.

The one-on-one engagement modules are statistically processed based upon accurate physics models. Countermeasures are explicitly included.

Stresses on the operating environment include both natural (sun, moon, storms) and battle-driven (jamming, weapon, nuclear) effects. Time evolution and time priority conflicts are included, as are the time delays for communication and computation.

Battle management options include local, global, and mixed algorithms. Possible real-time battle management schemes, including possible applications of artificial intelligence techniques, may be evaluated in the context of complete engagements.

The model features terminal-based, menu-driven input of all technical, order-of-battle, policy, and scenario parameters. A modular structure allows outside participation in the development and verification of code modules.

Separate terminal-based graphical routines provide output of analyzed data as specified by users. The computing network environment provides hardcopy, movie film, and microfiche of any output desired. Very large files may be maintained online for restart or for subsequent analysis.

DETEC is a very large program requiring several million words of storage. It was written for CRAY computer.

CATEGORY: I

ACRONYM: FAST STICK II

NAME: FAST STICK II

PURPOSE: The Air Command and Staff College (ACSC) uses the FAST STICK II exercise with the General Purpose Forces and Joint Operation Planning System phases of military employment instruction. The exercise provides participants with the opportunity to apply the concepts, roles, and missions of tactical air forces through the use of notional forces. Also, participants can apply quantitative techniques to determine weapon effectiveness and select strike flight composition to accomplish a desired damage expectancy.

ENTRY No(s): I-4

MODEL DATA: Fortran; Honeywell 6000 series

DESCRIPTION: FAST STICK II is computer-assisted, theater air war simulation. The exercise is set in a hypothetical scenario in which U.S. military forces help defend a friendly nation. FAST STICK II simulates the first 72 hours of the air campaign conducted by U.S. Air Forces.

Exercise participants function as members of the plans and operations branch of a Tactical Air Control Center. Participants plan and conduct tactical reconnaissance and strike missions based upon their concepts of operations and target priorities.

The FAST STICK II model simulates a complete mission sortie from take off to landing. Flights can be refueled on ingress and egress. All recce and strike sorties are subject to area and point defenses, such as interceptors, AA, and SAMs.

Notional aircraft types include Fighter, Attack, Recce, Wild Weasel, and Electronic Warfare. Strike and recce aircraft have a multiple pass or multiple target capability. Fighter aircraft may be used in strike, CAP or Air Defense roles. EW and Wild Weasel aircraft may be used in their normal roles in order to decrease strike aircraft attrition.

ACRONYM: FAST STICK II

DESCRIPTION: (continued)

All aircraft are subject to attrition by enemy defenses. Tactical Air Requests are randomly generated during the exercise to simulate immediate close air support requests from ground combat units. The response can be a diversion of an airborne flight or scrambling alert aircraft.

Enemy counterattacks are randomly generated. Counterattack defenses include both active and passive measures. Air defense alert aircraft may be scrambled to engage enemy aircraft. Other in commission aircraft may be vertically dispersed in order to decrease attrition probabilities.

Maintenance functions are simulated by subjecting all aircraft to an in commission check. Aircraft are either in or out of commission for 8 hours or out of commission for 24 hours.

The model includes weather parameters that affect combat operations. Weather forecasts, based on the weather parameters in the model, have been prepared for use during the exercise.

All necessary tables and matrices for probability of damage, flight times, and aircraft weapons load configuration are included in the exercise users' manual. All necessary forms, charts, and maps are included in the exercise package and examples of their use have been included in the users' manual.

The FAST STICK II simulation can handle from 1 to 99 teams on a time-sharing system. The model provides up to 40 flight call signs for each game day's flying. All flight scenario information is immediately provided to the team via the computer terminal. In addition, a batch print program provides faculty instructors with a summary of the team's daily flying activities.

CATEGORY:

I

ACRONYM:

HACES

NAME:

Helicopter Air Combat Effectiveness Simulation

PURPOSE:

To investigate the impact of flying qualities on mission effectiveness.

ENTRY No(s):

1-06

MODEL DATA:

Fortran

DESCRIPTION:

HACES is a Monte Carlo simulation model that has the capability to assess the effects of helicopter characteristics, numbers, tactics, and weapons on the ability of a force to accomplish a specific mission against a specified threat as a function of realistic tactical factors.

A key feature of the program is the simulation of micro-terrain features and the effects of those features on detection, exposure, and masking for nap-of-the-earth flight.

CATEGORY: 1

ACRONYM: INBATIM

NAME: INtegrated BATtlefield Interactive Model

PURPOSE: To simulate conventional and chemical warfare at the theater level.

ENTRY No(s): 1-28

MODEL DATA: Fortran; IBM 4341

DESCRIPTION: INBATIM is a deterministic computer model that simulates conventional and chemical warfare at the theater level.

The model determines daily and cumulative losses of ground weapons, aircraft, and personnel based on ground combat and air combat simulations involving conventional and chemical attacks. FEBA movement is a function of force ratio, terrain type, and the condition of forces in the sector. Reserve forces and supply consumption and movements are also modeled.

INBATIM is structured for future incorporation of a tactical nuclear warfare submodel.

The model needs approximately 600 input variables and arrays approximatley 60,000 data entries. All input data are uniquely identified for input into a base case set of data files. Preprocessor programs operating in time share mode are used for data entry and for format and variable verification. Most of the variables can be changed at specified times to reflect varying combat conditions.

Output consists of a detailed report, daily selected summary tables, selected summary reports, and a record of input decisions implementation for specified times.

Documentation consists of a system description volume and a set of appendices containing detailed information on input data files and variables.

CATEGORY: I

ACRONYM: JTLS

NAME: Joint Theater Level Simulation

PURPOSE: To assist planners in developing and evaluating theater level operations plans.

ENTRY No(s): 1-7

MODEL DATA: Simscript II.5; C language; Fortran; VAX 8600

DESCRIPTION: JTLS consists of four interrelated programs: a Start/Restart program, a Scenario Preparation Program which builds a data base, a Combat Events Program which is the warfare simulation model, and a Model Interface Program which transmits user orders to the Combat Events program.

The Combat Events Program is a two sided, event stepped simulation with graphics capability. The program features a heterogenous Lanchester equation attrition model. Ground, tactical air, and naval forces, and intelligence and logistic functions are represented.

Inputs include terrain and weather data; model parameters such as attrition coefficients; and performance, capabilities and effectiveness data of military equipment and units.

Output consists of current situation reports for units; operations summaries; air status, air route status, and logistics status reports for a force or unit; and intelligence reports at the national, strategic, and tactical level. A postprocessor is available to assist users in analyzing output data from the model.

CATEGORY: I

ACRONYM: MTOM

NAME: Mission Trade-Off Methodology

PURPOSE: To evaluate the relative cost-effectiveness of proposed aircraft modifications for survivability enhancement.

ENTRY No(s): I-08

MODEL DATA: Fortran

DESCRIPTION: The model calculates the life cycle costs (LCC) associated with a group of aircraft necessary to accomplish a prescribed mission. The fixed measure of effectiveness for an air-to-ground mission is the delivery of a required number of weapons on a given number of targets in a given time. The model determines the minimum number of initial aircraft required to accomplish the prescribed effectiveness and their costs.

Interactions between the aircraft and various enemy defenses are simulated by following a flight of aircraft. Probabilistic calculations are made for the attrition and the ability of the aircraft to find the targets and deliver the weapons. Expected value calculations are made for the ground turn around cycle of the aircraft to determine the sortie rate.

The costs include all aircraft losses and damage repairs as well as life cycle expenditures (RDT&E, procurement, training, operations and maintenance). Evaluations of S/V improvements are made by using the model to compute the total mission costs to accomplish the prescribed mission.

The model can be used without considering costs to calculate the effectiveness of an aircraft, or its modification, for a given scenario. Parameters can be varied easily so that sensitivity analysis and investigation of the effects of uncertainties can be performed. The model is modular and can be extended or modified by addition or replacement of submodels.

ACRONYM: MTOM

DESCRIPTION: (continued)

Two major submodels comprise MTOM: the MTO/E (Mission Trade-Off/Effectiveness) model evaluates the number of aircraft required initially to do a fixed job and the MTO/C (Mission Trade-Off/Cost) model calculates the LCC for the aircraft.

Extensive use is made of probabilistic and expected value calculations. Maintenance, damage repair and ground turnaround are treated and their effects are extrapolated over time.

The model is structure for a fairly short war (e.g., 30 days). Therefore, killed aircraft are not replaced until after the war.

The overall MTOM is structured so that for a given aircraft type the MTO/E model is first applied and then the MTO/C model. Thus, the MTOM model is a fixed-effectiveness variable-cost model.

This approach makes the model direct and simple since the number of aircraft lost in wartime are an important contribution to the total cost, and the number of aircraft lost is determined by the attrition and level of effectiveness required. By comparing the results for the standard aircraft with those of each design alternative, cost effectiveness evaluations can be obtained.

In one run, the model cycles through the various aircraft configurations considered. The program starts with the baseline or standard aircraft and proceeds through the modification candidates; up to nine candidates can be treated in one run.

The aircraft sortie survivability calculations are made as a function of time along the flightpath. The use of exponential survivability calculations simplifies the model and limits the number of input parameters. Supportive effects of a flight of aircraft flying together to the same general target area are incorporated.

The effects of multiple defensive weapons firing at an aircraft are incorporated into the MTO/E model. MTOM integrates PK for various aircraft flight segments into an overall sortie survivability and attrition calculation.

ACRONYM: MTOM

DESCRIPTION: (continued)

The model treats enemy weapon mixes to which an aircraft realistically may be exposed in almost any mission. This permits examination of survivability enhancement concepts and vulnerability implications against the lighter enemy weapons imbedded in a background of mixed enemy defenses.

Attrition can occur in one of two ways:

(1) based on input characteristics of enemy defenses, the model calculates the attrition for the aircraft sorties; or

(2) the model tunes the attack/defense interactions to an input nominal attrition for the baseline aircraft. The attrition for the modified aircraft is calculated relative to that of the baseline.

The MTO/C model treats future costs of RDT&E, aircraft modification or acquisition, peacetime operating cost and wartime operating cost. Thus, the model calculates absolute dollars. Incremental dollars associated with vulnerability improvements can be found by taking the differences between the costs for the basic aircraft and those for the modified aircraft.

A discount option enables the user to obtain the present value of future streams of money. For some decisions, this presents a useful way of comparing alternative courses of action.

Although the model can be used for any of several possible missions, the primary emphasis is on air to ground missions, particularly interdiction and air superiority (i.e., air base attack). With some reinterpretation of certain events, recce, assault, cargo, close air support, air-to-air, and escort missions can be modeled.

The model was developed in 1977.

CATEGORY: 1

ACRONYM: MULTIX

NAME: MULTiple Impact eXamination

PURPOSE: To evaluate the consequences of operational, environmental and technological options on the sortie generation capability of various aircraft types in a campaign environment.

ENTRY No(s): 1-05

MODEL DATA: 1000 Basic Statements; 5-10 sec. run time; written for the HP-9845 mini-computer.

DESCRIPTION: MULTIX is a campaign model that was developed in 1986 by Northrop Aircraft Division for the Global Tactical Presence study contract.

It is a deterministic model that allows the investigation of the effects of several parameter on the sortie generation capability of an aircraft in a campaign scenario.

Parameters characterizing airbase capability are:

- Base operating time
- Fuel storage capacity
- Maintenance and repair facilities
- Runway length

Operational and environmental parameters are:

- Length of flying day
- Fuel availability
- Runway availability
- Mission data (radius, loiter time)
- Attrition rate

Aircraft specific parameters are:

- Mission velocity
- Servicing time required
- Repair time required
- Reliability
- Mission fuel requirement
- Runway landing/take-off requirement

ACRONYM: MULTIX

DESCRIPTION: (continued)

The model is structured to fly a force of a specific type of aircraft (modeled by the aircraft specific parameters) from a specific airbase in a fixed scenario that is specified by the user. It computes sorties flown by the force on a day by day basis, accounting for attrition, daily changes in the conditions at the base, and daily variations in the operational and environmental parameter.

A variety of circumstances can be investigated by varying one or more of the parameters. For example, the impact of the presence or lack of fuel replenishment capability at an operating base can be examined by varying the fuel availability parameter on a day to day basis as the scenario progresses. Also, the effect of simultaneous variations in several parameters can be assessed.

Input requirements are considerable, including both aircraft, scenario, and system data. A separate program allows the creation or modification of data base sets.

Output is in the form of both hard data printouts and graphs, as selected. The graphical outputs show the daily sortie capability as a function of the parameter(s) selected for investigation and the total sorties generated over the campaign.

The model is not documented separately but is referenced in the final report for the Global Tactical Presence study.

CATEGORY: 1

ACRONYM: NAVMOD

NAME: NAVy MODEl

PURPOSE: To evaluate the combat outcomes of Naval Force interactions.

ENTRY No(s): 1-8

MODEL DATA: Fortran; IBM 4341

DESCRIPTION: NAVMOD is a aggregated, automated, deterministic model of naval combat between two opposing forces. One force can consist of aircraft carriers, escort ships, other surface ships, submarines, sea based attack and fighter aircraft, sea based land attack cruise missiles, and land based defensive aircraft. The other force can consist of surface ships and associated aircraft, submarines, land based attack and defensive aircraft, and ground defenses.

Command, control, communications, intelligence, electronic warfare, and mine warfare are not explicitly modeled. Numbers of types of aircraft and surface platforms are limited, requiring the aggregation of various types into one generic capability. Logistic capability is not included in the model.

The model requires that the the orders of battle for both sides and the factors describing the combat capabilities of all forces be entered. Geographical considerations of the opposing forces are not considered explicitly but may be included implicitly by adjusting the combat factors as the geography alters the capability of the weapons platforms.

The output reports the status of forces after each combat interaction, giving the expected value of the number of platforms remaining at full strength. A summary report gives the expected results after each time period.

CATEGORY: I

ACRONYM: OPTSA

NAME: OPTimal Sortie Allocation

PURPOSE: To compute allocations of general purpose aircraft to combat air support, airbase attack, and intercept missions.

ENTRY No(s): 1-10 and 1-11

MODEL DATA: 2,500 Fortran Statements; 50 sec. run time; CDC-6400 computer.

DESCRIPTION: OPTSA determines percentage assignments of general purpose aircraft to missions by period, where assessments of occurrences during the war are performed for certain numbers of days within each period.

The overall model is a zero-sum, two person sequential game, with simultaneous moves each day.

The solution to the game provides strategies for choosing assignments from lists of aircraft to optimize a desired measure of effectiveness. A choice of aircraft allocation is made by each side from its list of assignments at the beginning of each period. The choice may be made in a randomized manner and can depend on what choice each side has made in previous periods. Once an assignment is chosen, it must be played all the days in the period.

Input data consists of the number of types of divisions (up to 3 per side) and the number of types of aircraft. Up to three war periods of no more than 90 days may be specified.

Output includes a print out of input data, step results as events occur (such as losses, detection and kill parameters, etc.), and a daily summary.

Documentation of the model is in three volumes:

- 1: Methodology
- 2: Computer Program Documentation
- 3: The OPTSA Print-Run Program

This model was developed in 1975.

CATEGORY: 1
ACRONYM: SGM
NAME: Sortie Generation Model
PURPOSE: To relate aircraft spares and maintenance manpower levels to the maximal sortie generation capability of tactical air forces over time.

ENTRY No(s): 1-12

MODEL DATA: 15,000 FORTRAN statements; 8 CPU minutes run time;
Honeywell G-635

DESCRIPTION: SGM is a hybrid analytic/simulation model that estimates the expected maximal number of sorties that can be flown by a specific aircraft type in a wartime scenario.

The SGM consists of a collection of aircraft states, processes that cause transitions between states, and logic that governs more processes. SGM simulates the transition of aircraft between these states throughout a daily flying schedule that is specified by the user.

Input consists of the flying scenario and weapons system data; a maintenance manpower file describing the characteristics of the maintenance work center, and a recoverable spares file describing the characteristics of the line replaceable units being modeled.

Output consists of a summary of the scenario, a sortie profile showing the average number of sorties flown for each period, and a graph of daily sortie production.

Documentation consists of six volumes:

- 1: Executive Summary
- 2: User's Guide
- 3: Analyst's Manual
- 4: Programmer's Manual
- 5: Maintenance Subsystem
- 6: Spares Subsystem

The program was developed in 1981.

CATEGORY: 1

ACRONYM: SORTY30

NAME: SORTY30

PURPOSE: To help evaluate the effect of key factors on the ability of a single airbase to generate sorties during a war.

ENTRY No(s): 1-13

MODEL DATA: 3,300 FORTRAN statements; CYBER computer.

DESCRIPTION: SORTY30 can be described in general as a queueing model. At any moment, an aircraft is a "customer" either in or waiting to enter one of the following "service" locations:
-Repair or replacement of a failed system
-Repair of battle damage
-Repair of breaks and battle damage
-Refuel and rearm
-Take off from runway
-Aircraft attrition
-Attack enemy targets or defenses
-Land at airbase

The model considers the following factors affecting sortie generation:

- Ability to fly in adverse weather
- Aircraft ready rates, mean times between failures, and mean times to repair
- Mission duration and turn around time
- Repair queue resources
- Enemy ability to attack the airbase, damaging and killing queues and runways
- Attrition and damage of aircraft during sorties and while at base
- Impact of aircraft design parameters on reliability

Major features of the model include a Monte Carlo weather model chosen from an historical data base, discrete time steps, Monte Carlo branching, and a detailed queueing representation.

The physical system modeled is a single airbase maintenance and launch operation for a specified number of days. Sorties are generated as rapidly as possible with available aircraft. Weather and the effects of enemy air raids are inhibiting factors.

ACRONYM: SORTY30

DESCRIPTION: (continued)

Aircraft may sustain battle damage or normal system failures during a sortie. Attrition may occur at any point in the mission, including losses on the ground.

Throughout the war, the base repairs, refuels, and rearms aircraft around the clock, and attempts to launch sorties as early as possible, waiting only for flight size and other conditions to be met.

Input data required by the program includes initial and residual per sortie attrition rates, damage to kill ratio, initial number of defense units, operationally ready state, initial number of refrain stations, expected defense units killed per sortie versus targets, sortie/target allocations, days of war, mission sequence information, etc.

Output is in the form of summary statistics for results of sortie generation, reliability and repair, mission, airbase attack, and weather.

There have been four versions of the model, of increasing detail and complexity. The current version was developed in 1985.

CATEGORY:

I

ACRONYM:

TAC THUNDER

NAME:

TAC THUNDER

PURPOSE:

To simulate a conventional tactical air warfare campaign waged in central Europe.

ENTRY No(s):

1-16

MODEL DATA:

Simscrip II.5; IBM 360

DESCRIPTION:

TAC THUNDER is a two sided, theater level model designed to simulate a conventional tactical air warfare in central Europe. It includes a ground war component of sufficient detail to reflect the relative impact of the ground war on the air war. The model incorporates mission planning, explicit air missions, air mission sequences, air base operations, air-to-surface and surface-to-air attacks, and air-to-air combat.

Mission planning and intelligence is gathered and target lists are produced. Aircraft are allocated according to current resources, target priorities, and air apportionment orders reflecting theater commander guidance.

Battlefield defense, defensive counter air, barrier combat air patrol, escort, offensive counter air, close air support, battlefield interdiction, long range interdiction, reconnaissance, and defense suppression missions are simulated for both sides.

Flights may originate from several air bases and rendezvous at specific points. The flight group then proceeds to and from the target, sustaining losses during ingress and egress. Lethality is a function of probabilities of detection and kill, jammers, and air defense saturation factors.

Air to surface attacks are modeled by attacking components of a target, such as vans or runways. Some components are killed and others are damaged for a time period.

Takeoff and landing delays; refueling, rearming, and maintenance; and damage to runways, POL, munitions and shelters are dynamically changed based on model activity.

CATEGORY: 1

ACRONYM: TAC WARRIOR

NAME: TAC WARRIOR

PURPOSE: To perform analysis and change assessments in aircraft allocation.

ENTRY No(s): 1-17

MODEL DATA: Fortran; IBM 3032

DESCRIPTION: TAC WARRIOR simulates the allocation of tactical aircraft for various roles and missions including close air support, barrier air patrol, offensive counter air, defensive counter air, interdiction, electronic war, and other missions of a theater campaign.

Opposing forces can perform missions simultaneously with both employing up to four different airfield attack or interdiction aircraft, four different air defenses, three close air support aircraft, barrier combat air patrol aircraft, and three different airborne interceptors in the area of the FEBA.

The model accounts for the visual and radar search capability, speed, endurance, and armament of the fighter aircraft. Vector and warning capabilities of GCI and AWACS systems are included.

Air to air duels are modeled as either four, three, two or one versus one. The number of duels of each type is treated as a random variable dependent upon force allocations and commitment tactics, which determine the total number of aircraft that are engaged as a function of time.

Close air support mission effectiveness and attrition are based upon attacking targets in the forward edge of the battle area. The effectiveness and attrition continually change depending on the presence of electronic warfare support, the opposing level of surface to air defense, and target availability.

Barrier combat air patrol missions protect the close air support aircraft from the opposing air threat. Their level of effectiveness depends on the aircraft avionics and capabilities in air to air engagements.

ACRONYM: TAC WARRIOR

DESCRIPTION: (continued)

Offensive counter air missions are targeted against airbases, ground control intercept sites, and surface to air missile systems. Defensive counter air is responsive to the opposing offensive counter air missions. Associated with defensive counter air is the ground control intercept system and surface to air systems, including anti-aircraft artillery.

Interdiction missions are targeted against reserves and supplies.

The availability of an aircraft to perform each mission is dependent upon an airbase capability to generate ready aircraft.

The model will accommodate two classes of shelters, aircraft in shelters and in the open, five types of munitions, and POL. These elements and maintenance and servicing time are used to determine sortie generation. If the airfield is attacked, all the resources are at risk, including personnel. The damage depends upon how the airfield is populated at the time of the attack. The time necessary to perform maintenance and servicing increases as the resources are consumed or destroyed.

Inputs include aircraft probabilities of kill, sorties to target allocations, initial beddown information, and air to surface effectiveness.

Output consists of specified loop summaries, engagement summaries, and an executive summary.

CATEGORY: I

ACRONYM: TRACE

NAME: Tactical Resources And Combat Effectiveness

PURPOSE: To examine and quantify the impact on combat capability of changes in the numbers and type of air-to-ground non nuclear munitions available to the operational commander.

ENTRY No(s): 1-14 and 1-15

MODEL DATA: FORTRAN; 30-50 sec. run time; IBM 370/158

DESCRIPTION: TRACE is a one-sided expected value model that simulates the allocation and consumption of resources from a set of airbases in a combat environment. It estimates the results of applying a given set of tactical aircraft and air to ground conventional munitions against a specified array of enemy targets.

The model allows up to 20 airbases, 12 aircraft types, 35 target types, 25 munitions types, and 4 weather conditions. Runs of up to 90 days of simulated air operations are permitted.

Input consists of the number of each type of aircraft at various bases, aircraft performance and sortie rate information, quantity and type of munitions at each airbase, target data, allocation of sorties to missions, attrition data, and weather data including forecasting accuracy. Three auxiliary data preprocessing programs are used to prepare the input data.

The output consists of the expected number of targets destroyed, number of aircraft remaining, and the amount of munitions consumed.

The original model was written in 1973. An improved version incorporating attrition, attacks against enemy defenses, and flexible output format features was produced in 1975. Documentation in each case consists of a Programming Manual and a User's Manual.

CATEGORY: 1

ACRONYM: TSAR

NAME: Theater Simulation of Airbase Resources

PURPOSE: To analyze the interrelationships among the resources associated with a set of airbases and the capability of those airbases to generate aircraft sorties in a dynamic, rapidly evolving wartime environment.

ENTRY No(s): 1-18 through 1-26

MODEL DATA: 55,000 Fortran statements; variable run time; not machine dependent.

DESCRIPTION: TSAR is a Monte Carlo, discrete-event simulation model that simulates a system of interdependent theater airbases, supported by shipments from CONUS and by intratheater transportation, communication, and resource management systems.

On equipment maintenance tasks, parts and equipment repair, munitions build-up, and facilities repair tasks can be simulated for up to 63 airbases.

Eleven classes of resources are treated: aircraft, aircrews, ground personnel, support equipment, aircraft parts, aircraft shelters, munitions, TRAP, POL, bulding materials, and airbase facilities.

Asset accounting for each of the classes and for each type within each class permits investigation of the impact of permutations in assets or policy.

The simulation also allows examination of the effects of airbase damage inflicted by both conventional and chemical weapons, and the results of efforts to restore operations. A companion model, TSARINA, has been developed for damage assessment of complex airbase targets.

Input requirement is extensive and complex. Items include:

- Description of the personnel, equipment, spares, and time needed for each type of task;
- Quantities of resources available at time zero at each airbase, and replenishment schedules;
- Schedule of airbase sortie demand;
- Schedule of airbase attacks, and detailed percentage damage estimates for each attack

ACRONYM: TSAR

DESCRIPTION: (continued)

- Specification of theater transportation and communication characteristics
- Aircraft and mission data
- Various control and scenario variables

The input requirement is so extensive that a number of dedicated documents have been generated to provide accurate and consistant data for the principal TACAIR aircraft. These documents are denoted by the term "dictionary" and are the subject of an ongoing development process.

Output data is available in a variety of formats and includes:

- Number of flights and sorties flown by hour, mission, day, priority, and base
- Number of maintenance tasks performed
- Daily reports of work-rest times experienced in generic tasks
- Cumulative reports of personnel casualties, fatalities, and hospitalizations
- Shop performance statistics
- Activity data for on-base personnel
- Number of serviceable and repairable spare parts
- Summary task statistics by shop
- Statistics for each type of resource causing an aircraft delay

A dedicated document has been produced to explain the output and to present a computer code for transforming the output into a format suitable for standard analytical software packages.

Two versions of the model exist. The first was completed in 1982. The second version appeared in 1985 and included logic for assessing the effects of conventional and chemical attacks on airbases as well as other improvements and error corrections.

The second version resulted in a 60% increase in program statements (from 35,000 to 55,000) and a doubling of the memory requirement.

The documentation consists of four volumes - an Introductory Volume and a three volume User's Manual. The User's Manual was subsequently updated when the second version was developed.

CATEGORY: 1

ACRONYM: TWX

NAME: Theater War eXercise

PURPOSE: To allow players to gain insights into decision processes which relate principles of war, war fighting systems, and force employment decisions to military objectives of war.

ENTRY No(s): 1-27

MODEL DATA: Fortran; Honeywell 6000 series

DESCRIPTION: TWX is a two sided, theater level, wargame that uses air and land battle simulations to assess the impact of player resource allocation decisions in a NATO Central Region conflict scenario.

The air battle is dynamic and outcomes depend on force employment decisions made by the players, who represent force commanders. Players are compelled to select alternatives based on less than perfect information on both their own and opposing forces.

The land battle is preprogrammed over an initial five day conventional battle sequence representing the onset of a Pact military intrusion into Western Europe. The major variable influencing the land battle is tactical air power.

Forces are derived from unclassified sources and relative balance is projected for 12 to 18 months from the date of game play. The model permits interactive decisions to influence force beddown, logistics, and dispersal.

The full range of missions is modeled. The missions include offensive and defensive counter air, offensive air support, air interdiction, combat air patrol, defense suppression, electronic countermeasures, tactical air reconnaissance, and tactical airlift. Strategic Air Command forces and Strategic Reserve tactical air units may be time phased into the exercise.

The model will allow 80 air bases, 50 aircraft types, and 10 air munitions types per side. It will simulate two cycles per day, 300 land units per side, nine types of air missions, three weather states, and five exercise days.

Jordan and Associates

AF88-092 Phase I

SPECIFIC INTERACTION MODELS

<u>Acronym</u>	<u>Name</u>
AADEM	Avionics Air Defense Evaluation Model
AASPEM	Advanced Air-to-Air System Performance Evaluation Model
ABATAK	Air Base Attack
ABSGAM	Air Base Sortie Generation Analysis Model
ADAGE	Air Defense Air-to-Ground Engagement
ADPAS	Air Defense Penetration and Attack Simulation
ADWGSP	Air Defense War Game Support Program
AIRMODEL	
ATEM	Area Threat Engagement Model
CARMONETTE	
CASSANDRA	Close Air Support Simulation and Repair Algorithm
CASFOREM	Combined Arms and Support Task Force Evaluation Model
CEM	Concepts Evaluation Model
COLLIDE	
COUNTERAIR	
DADENS-C2	Divisional Air Defense Engagement Simulation - Command and Control
ENGAGE	
ESAMS	Enhanced Surface-to-Air Missile Simulation
FASTS	Fleet Anti-Ship Tactics Simulator
GUNVAL	
(LER)	Losses and Exchange Ratio
MABS	Mixed Air Battle Simulator
MACRO	
MISDEM	Mission/Damage Effectiveness Model

<u>Acronym</u>	<u>Name</u>
NEWAIR	
NWCAM	Naval War College Air Model
(OBRAA)	Optimum Base Recovery After Attack
PACAM	Piloted Air Combat Analysis Model
PROBE	
RAM	Runway Attack Model
RETCOM	Return to Combat Model
SCAN	
SCARE	Simulation of a Countermeasures, Aircraft, Radar Encounter
SGR	Sortie Generation Rate
SPEED	Simulation of Penetrators Encountering Extensive Defenses
TAC ASSESSOR	
TAC AVENGER	
TAC BRAWLER	
TAC DISRUPTER	
TAC EVALUATOR	
TAC LANCER	
TAC PROTECTOR	
TAC REPELLER	
TAC SUPPRESSOR	
TSARINA	TSAR Inputs Using Aida
VECTOR	

CATEGORY: 2

ACRONYM: AADEM

NAME: Avionics Air Defense Evaluation Model

PURPOSE: To evaluate EW, defense suppression, and counter C3 technology concepts and tactics.

ENTRY No(s): 2-01

MODEL DATA: Fortran; IBM 370/158; CDC Cyber 175; DEC VAX 11/780

DESCRIPTION: AADEM is a one sided, deterministic, time/event based, modular campaign model which simulates the penetration of aircraft in a scenario of tactical or strategic jamming aircraft, interceptors, ground based threats, and C2 networks. The many-on-many simulator includes terrain masking effects, modeling of terminal weapons, and the flexibility of autonomous or netted weapon firing philosophy.

Friendly ground forces are not modeled and limited provision is made for the air battle between the combat air patrol and the interceptors.

Inputs include scenario, penetrator weapons and countermeasures targeting details, air defense network details, C2 details, airborne interceptors and probability of kill data.

Output consists of computer printouts of event time history, attrition statistics, C2 response data, and data files for postprocessing.

Jordan and Associates

AF88-092 Phase I

CATEGORY: 2

ACRONYM: AASPEM

NAME: Advanced Air-to-Air System Performance Evaluation Model

PURPOSE: To investigate the military worth of emerging technologies as applied to the air-to-air battle.

ENTRY No(s): 2-02

MODEL DATA: 30,000 Fortran statements; VAX series computers

DESCRIPTION: AASPEM is used to investigate air-to-air combat effectiveness issues by parametrically adjusting weapon, sensor, airframe, and performance characteristics. It also involves the use of a large threat data base.

CATEGORY: 2

ACRONYM: ABATAK

NAME: Air Base ATtAck

PURPOSE: To model airfield sortie generation operations at the individual aircraft or asset level in order to assess the relative impact of different types of attacks against the airfield on sortie generation capability over time.

ENTRY No(s): 2-03

MODEL DATA: Fortran; VAX 11/780

DESCRIPTION: ABATAK can be used to model one or more airfields, in terms of their operating resources; the sortie generation process and turnaround requirements for refueling, rearming, and maintenance; and various facilities. A variety of mission profiles can be modeled. Attacks against the airfield can also be modeled based upon input parameters.

The multiple airfield version of the model portrays individual airbase operations in less detail, but will model aircraft movement between the fields.

Inputs include the number of aircraft, support crews and vehicles; number of minutes required to rearm, refuel, taxi, etc.; airbase physical geometry and length and width of airfield launch and recovery surfaces; location and capacity of munitions and POL storage; maintenance facilities, aircraft shelters, etc.; probability and duration of closure of attacks against the field; and other parameters.

The principal output is sortie generation over time by mission type. Base facilities utilization is also a model output.

The model was developed in 1983.

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AF88-092 Phase I

CATEGORY:

2

ACRONYM:

ABSGAM

NAME:

Air Base Sortie Generation Analysis Model

PURPOSE:

To simulate air base operations.

ENTRY No(s):

2-04

MODEL DATA:

Fortran

DESCRIPTION:

The model is sensitive to airbase/runway attack, aircraft R&M performance, aircraft takeoff and landing performance, and crater repair time.

CATEGORY: 2

ACRONYM: ADAGE

NAME: Air Defense Air-to-Ground Engagement

PURPOSE: To investigate the impact of air attacks on a ground war.

ENTRY No(s): 2-06

MODEL DATA: Fortran; UNIVAC 1100/83

DESCRIPTION: ADAGE is a damage assessment and weapons effectiveness model. It simulates an air attack on an Army division within the context of a ground war. The war is simulated over a period of days and consists of two submodels: Incursion and Campaign.

Incursion is a Monte Carlo model that determines the attrition of one aircraft due to fire from one ground based weapon. Campaign uses the Incursion outputs to simulate a many-on-many aircraft versus Army division game using deterministic methods. Air defense engagement parameters such as detection ranges and intercept data for various conditions and level of attrition are available as end game data.

ADAGE was designed for company sized maneuver forces and air defense fire units. Maneuver forces can be varied between platoon and battalion levels if the model and data inputs are modified. The model can be played for units up to Army divisions of various types.

Inputs include threat aircraft characteristics and vulnerabilities, air defense system data, aircraft flight paths, scenario data, ground war loss rates, munitions effectiveness, and material repair and refurbishment rates.

Output includes air defense system effectiveness, losses, summary statistics, and force-on-force war game results.

CATEGORY: 2

ACRONYM: ADPAS

NAME: Air Defense Penetration and Attack Simulation

PURPOSE: To determine the survivability of an aerial platform against AAA, aerial interceptors, and EW.

ENTRY No(s): 2-07

MODEL DATA: Fortran; UNIVAC

DESCRIPTION: ADPAS is a two sided, deterministic, division level simulation that can play up to 300 aircraft. It accounts for the C3 function and has a target acquisition capability that can be used to assess the effectiveness of sensors at the engineering level.

Smoke, obscurants, and communications jamming are all played in terms of degradation factors. AAA cannot be played simultaneously. The model does not play DF, chaff, ARMS, or ECCM against radar or communications jamming, or against incidental or deployed smoke.

Input includes weapon and aircraft characteristics; scenario, terrain and radar data; flight profiles; jammer characteristics; and weather.

CATEGORY: 2

ACRONYM: ADWGSP

NAME: Air Defense War Game Support Program

PURPOSE: To provide one-on-one probabilities of engagement and kill for a variety of forward area air defense systems against different types of aircraft.

ENTRY No(s): 2-11

MODEL DATA: 2,500 lines of Pascal code; written for micro-computers.

DESCRIPTION: The results of an interaction between an air defense unit and an aircraft are determined by comparing a program generated random number with threshold values calculated from data tables.

An engagement is modeled only as an interaction between the air defense system and that aircraft and does not consider the particular killing mechanism of the weapon.

The factors used in the calculation of the engagement and kill thresholds may be changed. Also, the probabilities of air defense system attrition and aircraft suppression, the attrition factors and the random number seed may be changed.

Each air defense system is defined by weapon type (Vulcan, Sgt York, Redeye, Stinger, Chaparral), location (Europe, desert, jungle), and level of effectiveness.

Each aircraft is described by type (helicopter, transport, fighter), tactic (pop-up, lay-down, fly-over), and whether the air defense system suffers any attrition from an aircraft that was engaged but not destroyed or suppressed.

The model was developed in 1985.

CATEGORY: 2

ACRONYM: AIRMODEL

NAME: AIRMODEL

PURPOSE: To simulate aircraft attrition in the air defense environment

ENTRY No(s): 2-47

MODEL DATA: 1,000 Fortran statements

DESCRIPTION: AIRMODEL is a high resolution computer simulation model of aircraft attrition in the air defense environment.

The model employs extensive pre-processing submodels and programs in order to efficiently examine tactical scenarios and reduce program execution time. The pre-processing outputs are loaded into a dynamic simulation submodel to analyze the aircraft/air defense engagement sequence.

The overall simulation model is modular and can be easily modified to satisfy particular analysis objectives.

The model was developed in 1986.

CATEGORY: 2

ACRONYM: ATEM

NAME: Area Threat Engagement Model

PURPOSE: To simulate many-on-many penetrator and air defense interactions to determine offensive and defensive weapon system assignments.

ENTRY No(s): 2-17

MODEL DATA: Fortran

DESCRIPTION: ATEM simulates the penetration of an air defense network, solves the radar equations at each radar site and penetrator location, and finds signal to noise and jamming to strength ratio time histories. In the case of jamming, individual beams of multi-beam radars such as height finders or certain early warning radars are selected on the basis of the lowest ratio.

Aircraft flight is simulated point to point with velocity adjustments for proper aircraft arrival time at the checkpoints. All aircraft maneuvers are preprogrammed.

The radar module carries the simulation to the point where the penetration vehicles appear on the various radar screens above detection thresholds.

Jamming options include noise, repeaters, targets, saturation, discrete electronic targets, range rings, and electronic. Jammers are activated based upon the radar circumstances and the discrimination logic employed in the jamming receiver.

ATEM is coded for 128 radar sites and 16 penetrator vehicles.

CATEGORY: 2

ACRONYM: CARMONETTE

NAME: CARMONETTE

PURPOSE: To analyze battalion level combat doctrine and tactics.

ENTRY No(s): 2-18

MODEL DATA: Fortran; Sperry 1100 series

DESCRIPTION: CARMONETTE is a stochastic, event step simulation of a combined arms air or ground war game. It is played on a variable terrain representation of grid squares at 100 meters resolution for one hour of combat engagement. Representation of infantry or various vehicles including tanks, armored personnel carriers, air defense, and helicopters is at the individual up to platoon group size in a battalion level force.

Events pertaining to surveillance consider the effects of battlefield obscuration due to weather, aerosol smoke, and artillery dust. Probabilities of hit and kill consider the biased dispersion of weapons systems based on moving firer and targets.

CARMONETTE does not treat logistics and a player cannot change tactics during a single game. A version of the model has been written for very small unit interaction.

Input includes troop lists; weapon lists, accuracy, performance data, and lethality; sensor performance data, vehicle mobility and vulnerability; tactical scenario; and terrain data.

Output includes a listing of assessed events, with a summary of all casualty events and a summation of kills by target and weapon type. Also available are summaries of weapon engagements shown by target type, rounds fired, personnel killed, and vehicles destroyed for each of the selected range brackets.

CATEGORY: 2

ACRONYM: CASSANDRA

NAME: Close Air Support Simulation AND Repair Algorithm

PURPOSE: To allow study of the effectiveness of various types of aircraft in a close air support role.

ENTRY No(s): 2-19

MODEL DATA: Basic; Wang 2200

DESCRIPTION: CASSANDRA is a deterministic model that calculates the probability of aircraft surviving attacks by interceptors, SAM, and AA guns as the aircraft are subjected to search, detection, acquisition, and attack. Types of ordnance and delivery tactics can be varied as well as visibility conditions.

Ground targets include artillery, personnel, and tanks. The model computes damage to ground targets and number of aircraft damaged or destroyed. One criteria of effectiveness is the number of targets killed per aircraft destroyed.

The model can examine only a single type of ground target and one aircraft type in each run.

Inputs include various probabilities of engagement, acquisition, and kill or survival as a function of tactics or ordnance type; damage to kill ratios; and repair times.

Output consists of kills and damage by weapon type, target kills, aircraft availability, and various ratios.

CATEGORY: 2

ACRONYM: CASTFOREM

NAME: Combined Arms and Support Task FORce Evaluation Model

PURPOSE: To simulate ground combat interaction

ENTRY No(s): 2-20

MODEL DATA: SIMSCRIPT II.5; VAX 780

DESCRIPTION: CASTFOREM is a stochastic, event-sequenced, opposing forces simulation of ground forces combat up to the battalion level. The model is designed to be used in an automated mode with variable unit resolution at the individual weapon system level. Resolution of terrain is also variable.

In general, all combat support and combat service support units and functions which interact with and/or directly affect the combat activities of maneuver units are represented in the model. The CASTFOREM structure will facilitate increasing or decreasing the degree of resolution at which specific vehicles, weapons, and functions are represented to satisfy study objectives.

CASTFOREM is the lowest echelon member of a hierarchy of models which also includes theater (FORCERM) and corps/division level (CORDIVEM) force-on-force simulations. It was developed in 1983 as a part of the Army model improvement program.

Input data include: terrain description parameters, environment data, weapon effects data, decision tables, organizational structures, unit orders, communications data and networks, equipment data and personnel description parameters.

CASTFOREM output may be generated in three forms: graphics, hard copy, and binary history. Graphics output consists of impact events, movement, and firing events. Binary history and hard copy output can be generated for audits on specific units or on some or all events generated by a specific module. The binary history consists of user-specified events and may be used, via the post processor, to produce hard copy, graphics, and further binary output.

CATEGORY: 2

ACRONYM: CEM

NAME: Concepts Evaluation Model

PURPOSE: To simulate a theater level, non nuclear war in terms of FEBA location and movement, condition of opposing forces, and expenditure of resources, to determine the effects of resources, modernization, and force structure, and to determine wartime resource requirements.

ENTRY No(s): 2-22

MODEL DATA: Fortran; Sperry 1100/84

DESCRIPTION. CEM is a two sided, deterministic model designed to consider up to 210 units of brigade size on one side and up to 125 units of division size on the other. Command decision processes are simulated at four echelons - division, corps, Army group, and theater.

Simulated time is treated on a time step basis at nested intervals of 12 hours to 4 days, depending upon the echelon. Theater supply, replacement, maintenance, repair, and hospital functions are simulated.

The model calculates losses by extrapolation from high resolution combat simulations. FEBA movement is a function of terrain, posture, and loss rates. Air defense and tactical aircraft types, logistics, combat support, service support, and ammunition types are highly aggregated.

Inputs include terrain map, troop lists, tables of various types of equipment and supplies, resupply and replacement rates, arrival schedules, and FEBA movement tables.

Output consists of time tracks of FEBA location, posture profiles, resource expenditures, losses and damages, and states of forces.

Several versions of the model have been created for specific purposes, such as the effects of C3I and EW (CEM/TFECS) or various communications network architectures (CEMTACS).

The model was developed in 1972.

CATEGORY: 2

ACRONYM: COLLIDE

NAME: COLLIDE

PURPOSE: To compute airborne interceptor probability of detection and conversion to armament launch position for given target characteristics and tactics, under varying equipment, ECM, command and control, and geometric conditions.

ENTRY No(s): 2-23

MODEL DATA: Fortran; IBM 3081

DESCRIPTION: COLLIDE is a one sided, deterministic, aggregated model designed to assess the impact of command and control on interceptor conversion. It concentrates on the terminal phase of interception. Co-altitude radar detection, altitude differentials, infrared and doppler radar detection, and electronic counter measures may be modeled.

Input consists of the intercept fighter and bomber radar performance, and ECM performance against fighters.

The principal output of the model is probability of detection and conversion.

The model was developed in 1976.

CATEGORY: 2

ACRONYM: COUNTERAIR

NAME: COUNTERAIR

PURPOSE: To evaluate aircraft survivability and target damage during offensive counterair operations.

ENTRY No(s): 2-65

MODEL DATA: 3,200 SLAM/Fortran statements

DESCRIPTION: This model simulates a mission of two aircraft attacking an area target at an enemy airfield.

The area of operations is contained within a ten mile radius circle centered in the airfield's runway. Located within this area are the target and ground based defenses.

The model is written using the SLAM language with extensive use of FORTRAN and allows investigation of three-dimensional aircraft movements, threat engagements, and pilot reactions. Included in the logic is an analytical routine used to assess target damage due to weapons effects.

The routine is based on a methodology contained in the Joint Munitions Effectiveness Manual.

CATEGORY: 2

ACRONYM: DADENS-C2

NAME: Divisional Air Defense ENgagement Simulation - Command and Control

PURPOSE: To investigate the effectiveness of offensive and defensive force command and control systems.

ENTRY No(s): 2-28

MODEL DATA: Fortran and Assembler; CDC 6000 series

DESCRIPTION: DADENS-C2 is a general war, damage assessment and weapons effectiveness model designed to simulate either one sided or two sided war games. It will simulate land, sea, or paramilitary forces. The level of aggregation is one fire unit to one threat vehicle.

The model simulates operation of alternative air defense command and control systems, and will investigate in detail complex situations involving the interaction between offensive and defensive forces; offensive or defensive forces, or command and control, and the environment; and command and control defensive forces.

The model operates on a grid zone system and is designed to 444 defense entities, 28,665 offensive objects, and 2,047 communication lines with a range of possible manipulation to include any combination of offensive and defensive systems. Simulated time is treated on an event stored basis. It uses Monte Carlo techniques to determine the results of events that influence future events.

Inputs include threat identifiers, launch times, hostile burst times and locations, turn points, velocities, and nodes representing command and control centers, relay stations, and switches.

The principal output consist of summary reports and sorted lists of messages.

The model was developed in 1986.

CATEGORY: 2

ACRONYM: ENGAGE

NAME: ENGAGE

PURPOSE: To estimate the probability of detection and conversion of an air interceptor on a penetrating air vehicle.

ENTRY No(s): 2-30

MODEL DATA: Fortran; VAX 11/780; IBM 3032; IBM 3081

DESCRIPTION: ENGAGE is a deterministic model that estimates the probability that a single air interceptor will radar detect a single penetrator and convert to a missile firing position. ENGAGE has three degrees of freedom and will model detection of penetrators in clutter.

Input includes radar cross section data, radar and missile parameters, turn and acceleration data, launch envelopes and flyout tables, signal to noise criteria, and single sweep detection probabilities.

Output consists of detailed data on detection, conversion, and attack.

CATEGORY: 2

ACRONYM: ESAMS

NAME: Enhanced Surface-to-Air Missile Simulation

PURPOSE: To support assessments of vulnerability and survivability of current and future U.S. Air Force Weapons systems.

ENTRY No(s): 2-31

MODEL DATA: Fortran

DESCRIPTION: ESAMS is a digital computer program which models the interaction between a single airborne target and a SAM air defense system.

The functional components include detailed modeling of sensor lock-on and tracking parameters, missile flight dynamics, missile guidance, and autopilot loops, target vulnerability, warhead detection, fusing, and detonation characteristics, and ECM techniques. Missile and radar input parameters are specific to each SAM system modeled.

CATEGORY: 2

ACRONYM: FASTS

NAME: Fleet Anti-Ship Tactics Simulator

PURPOSE: To simulate a many-on-many war-at-sea scenario.

ENTRY No(s): 2-34

MODEL DATA: 1,400 BASIC statements; HP-9000/520

DESCRIPTION: This program simulates a many-on-many war-at-sea scenario involving ship based early warning radars, strike aircraft and supporting radar jammers. It provides the tactics designer a testbed for evaluating strike tactics against a defensive radar network and for estimating the impact of environmental conditions on radar detection.

FASTS is implemented on an unbounded X-Y coordinate grid and is controlled by a main routine clock that steps from time zero to a input finish time. FASTS does not model ship motion or the effect of wind, radar transmission loss for targets above 10,000 feet, effects of jammer antenna blanking caused by maneuvering of the jammer aircraft, or radar returns from sea clutter.

The model can be used for designing and simulating plans for coordinated strikes, investigating radar visibility of aircraft under both standard and anomalous propagation conditions, and evaluating the effect of jamming on aircraft detection in a dynamic scenario.

Input data include: atmospheric conditions; parameters and the number of data elements present for radars, jammers and aircraft; type and location of each radar; types of radar systems; type and initial position and velocity for each aircraft; and aircraft flight profile.

Output data consist of a time history of aircraft position, velocity, and probability of detection; a geographic plot of aircraft tracks and visibility; a plot of aircraft detectability versus time; and a simulation-based table of expected first-detection ranges for each aircraft and radar combination.

The model was developed in 1985.

CATEGORY: 2

ACRONYM: GUNVAL

NAME: GUNVAL

PURPOSE: To evaluate the effectiveness of fighter aircraft gun systems in air-to-air combat.

ENTRY No(s): 2-36

MODEL DATA: Fortran; IBM 3081

DESCRIPTION: GUNVAL is designed to integrate a multitude of gun and projectile performance parameters into a single measure of kill probability. Parameters include the effects of high firing rates, gun acceleration reliability, projectile lethality, target maneuver bias, and tracking error.

GUNVAL uses as input a gun firing opportunities file that is an output of the TAC AVENGER air combat simulation model. The file describes the positions of the attacker and target during the burst and gives a realistic distribution of the firing conditions expected during a duel between two airplanes for which no actual combat exchange data are available.

Output includes range, time of flight, velocity, burst length, rounds fired, and kill probability of each burst.

The model was developed in 1976.

CATEGORY: 2

ACRONYM: (LER)

NAME: Losses and Exchange Ratio

PURPOSE: To investigate the results of aerial combat between large numbers of modern fighters in a central European scenario.

ENTRY No(s): 2-46

MODEL DATA: 2,500 SLAM/FORTRAN statements; VAX 11/780

DESCRIPTION: A computer model based on a central European NATO-Warsaw Pact conventional conflict was built using FORTRAN and the SLAM simulation language. The model allows engagements of 144 aircraft. Blue aircraft operation from CAP stations defend against Red fighter-bombers escorted by Red fighters.

Only two types of aircraft are modeled: the McDonnell-Douglas F-15 and the MIG-23/27. The model is empirically based and simulates the physical movement of the aircraft, radar and visual detection and employment of radar and heat-seeking air-to-air missiles and aerial cannon.

The model was developed in 1983.

CATEGORY: 2

ACRONYM: MABS

NAME: Mixed Air Battle Simulator

PURPOSE: To study factors that affect the effectiveness of air defense systems.

ENTRY No(s): 2-41 and 2-42

MODEL DATA: FORTRAN; CDC 6400/6600; WAND VS80B; VAX 11/730

DESCRIPTION: MABS is a two sided, stochastic model designed to simulate battles in which ground based air defenses and interceptors on one side oppose coordinated air defense and interceptors on the other side. It is concerned with the evaluation of tactics, threat responses, rules of engagement, ECM levels, air refueling, and the effects of defense in various types of terrain foliage.

The model considers SAM sites, manned interceptors, anti-aircraft guns, and threat vehicles on either an individual or aggregate basis up to a maximum of 255 ground sites, 100 interceptors, and 800 threat vehicles. Simulated time is treated on an event store basis.

Effectiveness calculations are a function of the ability of the air defense system to inflict damage and prevent damage to itself. Probability theory and numerical analysis are the primary solution techniques used.

Input data requirements include weapon system performance parameters, delay times, rates of fire, etc.; geographical locations of defense entities; flight paths of enemy aircraft; damage parameters; flight tactics; and engagement doctrine.

Output consists of a battle history of results or statistics of one or several replications.

The model was developed in 1972. The most recent version of the model was developed in 1984.

CATEGORY: 2

ACRONYM: MACRO

NAME: MACRO

PURPOSE: To investigate ground and air combat.

ENTRY No(s): 2-43

MODEL DATA: Fortran; Cyber 173

DESCRIPTION: MACRO is a two sided, aggregate, deterministic representation of ground and air combat in the NATO Central Region. Structurally, it consists of a set of differential equations describing status changes or force strength changes in various areas, FEBA positions and velocity, cumulative commitments and losses, etc. The equations are solved by Runge-Kutta techniques.

The forces simulated in MACRO consist of aircraft and helicopters, ground forces not otherwise broken out, artillery, and LAWS. Forces may be at three distinct depths within a corps area or may be in the region behind the corps area.

Forces are affected by seven processes including arrival, commitment of forces, forward or rearward movement, attrition, retirement, reconstitution of retired forces, and repair of kills.

Macro is constructed to use the results of the VECTOR campaign model.

Input includes initial state information, region level data, corps level performance data for each corps, data describing force reconstitution, and force arrival data.

The primary output is a tabular summary of the situation printed at user selected intervals. It includes force strengths, allocations, kills, FEBA position and speed, and other data as desired.

The model was developed in 1983.

CATEGORY: 2

ACRONYM: MISDEM

NAME: MISSION/Damage Effectiveness Model

PURPOSE: Survivability/Vulnerability Analysis in a Mission or Campaign Setting.

ENTRY No(s): 2-45

MODEL DATA: 1,000 Fortran statements; IBM 370/168

DESCRIPTION: MISDEM is a survivability/vulnerability model that transforms aircraft subsystem probabilities of survival into probabilities of aircraft survival.

It simulates an aircraft and its subsystems experiencing a time series of events. The events may include targets to be attacked, threat weapons to be encountered, refueling, recovery at an air base, or certain events selected by the user.

The model may be used to compute measures of effectiveness, such as numbers of targets killed in a mission or a campaign. It is intended for use in measuring the impact of vulnerability of subsystems on aircraft survival and effectiveness for unenhanced or protected subsystems.

Each defensive event requires the input of the effectiveness of the enemy's defensive system against each aircraft component/subsystem for each mode of operation. The offensive events require the input of weapon effectiveness for each target type of each possible mode of delivery.

The basic structure of MISDEM requires the aircraft system being studied to be divided into two complementary elements: the electronic and the vehicle functions. The program is run separately for the electronic and the vehicle, utilizing different input for each.

Output consists of system and subsystem survival probabilities and the probabilities of the system operation in each mode.

The model was developed in 1979.

CATEGORY: 2

ACRONYM: NEWAIR

NAME: NEWAIR

PURPOSE: To simulate a conflict between air forces employing conventional weapons.

ENTRY No(s): 2-48

MODEL DATA: SIMULA-67; CDC 6400

DESCRIPTION: NEWAIR is a deterministic, time step model that computes the attrition of attacking and defending aircraft, and the damage inflicted on runways, shelters, aircraft on the ground, and terminal defense weapons. The model will also compute the number of sorties delivering ordnance to close air support and interdiction targets. The computations are performed separately for each target attacked and reflect the weapons and aircraft actually participating in each engagement.

The model will accommodate 40 aircraft types and 150 air bases.

The model is designed for the evaluation of relative air force capabilities in central Europe. It can be used for interactive wargaming, with the players communicating with the program through remote terminals. A completed campaign, conducted interactively, may subsequently be run as a batch job to perform sensitivity excursions.

Inputs include aircraft performance, airbase, CAP pattern, target, and attrition data.

Model output consists of an attrition summary and airbase, CAP pattern and counter air reports.

CATEGORY: 2

ACRONYM: NWCAM

NAME: Naval War College Air Model

PURPOSE: To conduct air to air and air to land wargaming within the large battle context of the Global War Game.

ENTRY No(s): 2-49

MODEL DATA: Basic; Microcomputer (256K)

DESCRIPTION: NWCAM is an interactive, two sided, stochastic simulation of tactical air warfare. It evaluates both original and prepackaged air strikes against a variety of targets in multiple environments. It also features tracking of aircraft and relative factors at each base.

The simulation rate is at least one combat day in four hours of game play. Missions of opposing forces can be run in parallel.

Input includes raid parameters including escorts, attack aircraft and ordnance, target assignments, and defensive factors.

Extensive output in the form of data, interactions and mission results are provided.

CATEGORY:

2

ACRONYM:

(OBRAA)

NAME:

Optimum Base Recovery After Attack

PURPOSE:

To determine optimum sequences of recovery actions following each of a series of attacks, including both bombs and mines.

ENTRY No(s):

2-44

MODEL DATA:

17,000 Fortran statements

DESCRIPTION:

The objectives of the model are to simulate the various features of attacks and recovery operations and to determine a sequence of recovery activities that is optimal in terms of facilitating the performance of the air base mission.

The primary control variables of the model are related to crater repair and mine clearance on prepared surfaces. Variables relating to the repair of aircraft are viewed as secondary control variables. The model is not designed to develop a detailed description of optimal aircraft repairs.

Input data include: air base configuration corresponding to taxiway and takeoff-capable surface locations; bomb and mine data; air base operations and war options.

Output options include: last attack and the optimum recovery which has been determined for it; summary of all attacks and all recovery operations.

The model was developed in 1985.

CATEGORY: 2

ACRONYM: PACAM

NAME: Piloted Air Combat Analysis Model

PURPOSE: To assist in the evaluation of aircraft, armament, and tactics by simulating the performance of aircraft and weapons in combat.

ENTRY No(s): 2-52 through 2-56

MODEL DATA: Fortran; CDC 6600; CYBER 70

DESCRIPTION: PACAM is an aircombat simulation model that is widely used throughout the U.S. Air Force and Navy, and in the RAF, as well. Several versions of the model have been created, the most recent being PACAM VIII, developed in 1983.

PACAM I was developed for the Aeronautical Systems Divisions/Research (ASD/XR) starting in 1968. It was designed to simulate one-versus-one aerial combat in three dimensional space.

Both sides used the same tactics and a limited maneuver suite. Each aircraft fought unaware of weapons usage by his foe. The flight path data resulting from the simulation was stored on tape to allow the later evaluation of weapons firing opportunities.

Under the auspices of the Air Development Test Center, the evaluation program was expanded to include air-to-air missiles. The missile flyout was analyzed against the previously stored flight path of the target aircraft.

PACAM I was actually a system of three separate models: Model B (duel); Model E (weapons); and Model D (end game).

PACAM II was developed to overcome some of the limitations in PACAM I. The major changes were made in the area of tactics.

Asymmetrical tactics were permitted; the two sides were allowed to make different decisions under various conditions. A "level of aggressiveness" factor was incorporated. Nonaggressive (escape) tactics were included for poor position and low fuel situations.

ACRONYM: PACAM

DESCRIPTION: (continued)

The decision process was based on user-supplied tables which facilitated the incorporation of additional tactics. More significantly, PACAM II was designed to permit multi-aircraft combat. Several tactical routines were developed for this purpose.

PACAM II continued to use the partitioned model concept (B, E, D,), which implied that manuvering, both offensively and defensively, was independent of weapons firing. This limitation led to the development of PACAM IV.

The major tactical goal of PACAM IV was to permit dynamic reaction to weapons firing, with all the concomitant effects. It was necessary to merge the three models (duel, weapons, and end game) into a single program and to provide the necessary subroutines to allow their interaction.

Those dynamic weapons provisions, plus the desire by the Laser Engineering and Application for Prototype Systems Office at Kirkland AFB to use PACAM for bomber defense evaluation, led to another series of changes in PACAM IV. Vehicle sizes vary from B-52 aircraft down to AIM-9 missiles. This variation required that the detection range be made a function of the target size and aspect, as well as of the type of sensor.

An optional Monte Carlo routine provides a stochastic determination of the kill evaluation and missile detection variables. Bomber penetration and defense tactics are available, as are tail defense weapon screening, firing, and evaluation.

The next major modification, PACAM V, consisted of the inclusion of ground-launched, surface-to-air missiles (SAM). PACAM V also has improved handling of sensor characteristics, target description, and kill evaluation. The ability to model one versus one combat is retained.

The most recent modification of the model, PACAM VIII, significantly increases the size and complexity of the problem that can be analyzed.

CATEGORY: 2

ACRONYM: PROBE I

NAME: PROBE I

PURPOSE: To simulate the interaction of an attack air force versus an interceptor defense in a conflict extending over as many as thirty missions.

ENTRY No(s): 2-57

MODEL DATA: 2,500 Fortran statements; 2 second run time; IBM 370/158

DESCRIPTION: For any mission, attack sorties may be allocated to any combination of bombs-only aircraft that are assigned to prime targets, similar aircraft targeting hostile interceptor bases, or aircraft with only air-combat weapons that defend the bombers.

The model will determine the outcome of one or a series of missions with specified allocations. Alternatively, it can determine, mission by mission, the allocations that (with the total number of missions specified) will maximize a given objective, such as total bomb tonnage reaching prime targets.

Inputs are detailed and extensive, describing the missions assigned, aircraft characteristics, and expected bombing success probabilities. The model predicts the total mission performance for the specified number of sorties and aircraft of various types and combinations.

The model was developed in 1974.

CATEGORY: 2
ACRONYM: RAM
NAME: Runway Attack Model
PURPOSE: To aid in planning runway attack
ENTRY No(s): 2-21
MODEL DATA: Fortran language; 10-200 sec run time; CDC-6600;
uses IMSL subroutines
DESCRIPTION: RAM is designed to aid the planning of runway attacks. Conventional, individually targeted weapons are used against non-reinforced concrete runways.

The program has two main sections. The first section evaluates any attack strategy, based on independent cuts along the runway, with each cut specified in terms of number of aim points, number of weapons per aim point locations.

The second section searches for the "best" strategy which uses the least number of weapons to achieve an overall probability of runway closure equal to or greater than a user specified level.

The program operates in three modes. The mode 1 program returns the fewest number of weapons and the "best" strategy in order to meet or exceed a user defined level of runway closure.

Mode 2 allows the user to specify a fixed number of weapons instead of a level of runway closure and the program returns the highest probability of runway closure and the "best" strategy to use with the fixed number of weapons.

Finally, Mode 3 allows the user to completely specify a strategy in terms of number of cuts, cut locations, number of aim points per cut, number of weapons per aim point and locations.

The model was developed in 1982.

CATEGORY: 2

ACRONYM: RETCOM

NAME: RETurn to COMbat

PURPOSE: To simulate the return to service of failed or combat damaged items of a combat force.

ENTRY No(s): 2-61

MODEL DATA: Simscript II.5; Univac 1100 series

DESCRIPTION: RETCOM is a stochastic, event oriented model that simulates up to 4095 individual items of a single system type (e.g., XM1 tank or 10 ton truck) of a combat force organized into a company or a battalion engaged in a predefined set of common tasks (movement, engagement, or inactive periods).

During the performance of the tasks the items in the force are allowed to suffer combat damage and mechanical failure, be repaired, and be returned to the combat force.

Input data include: force structure, definition of equipment to include components and vulnerability, levels of maintenance, recovery or evacuation capability, component reliability, and scenario.

The model produces a summary of the system performance which includes: estimates of operational availability and mission reliability for each item and the force; total number of RAM failures and the number of failures for each major component; total combat hits received by the force and the resulting consequences; maintenance asset utilization in terms of diagnostic and repair time, and any administrative or logistic delay; and time sequenced history of events, such as RAM failure, each component hit and resulting consequences, repair action and item recovery.

The model was developed in 1982.

CATEGORY: 2

ACRONYM: SCAN

NAME: SCAN

PURPOSE: To assess aircraft survivability against a specified missile threat.

ENTRY No(s): 2-10

MODEL DATA: 2,000 Fortran statements; IBM 3033

DESCRIPTION: SCAN provides an analytical means of assessing aircraft survivability against a specified missile threat.

The encounter between an airborne target and a fragmentation warhead known as the "Endgame" is mathematically simulated and impact computations are carried out for all fragments impacting a geometrical representation of the target.

Input consists of target, case and warhead data.

Output consists of both statistical and graphical summaries including survival probabilities and target distributions.

The program was developed in 1982.

CATEGORY: 2

ACRONYM: SCARE

NAME: Simulation of a Countermeasures, Aircraft, Radar Encounter

PURPOSE: To simulate a countermeasures, aircraft, radar encounter.

ENTRY No(s): 2-63

MODEL DATA: 40,000 Fortran statements; VAX/VMS

DESCRIPTION: SCARE is a one-on-one or few-on-one engagement simulation. A typical engagement scenario consists of one or two maneuvering aircraft deploying countermeasures flying against a single threat system.

The detailed nature of the model precludes using SCARE for battlefield style simulations. The effectiveness of chaff, jamming, maneuvers, and combinations of these countermeasure techniques can be evaluated using the program.

Two modules, RADAR2A and MISSILE1, together comprise a combined SCARE module.

RADAR2A is a detailed simulation of a specific semiactive continuous wave seeker, while MISSILE1 models a specific surface-to air missile. The actual seeker and missile are part of a surface to air missile system that also includes a target tracking radar.

Either RADAR2A or MISSILE1 may be run independently by modifying input parameters.

Input data include setup parameters, RADAR2A design parameters (antenna pattern, signal, angle tracker, dippler tracker, doppler search, angle error demodulator, AGC, receiver), and missile design parameters.

Output data consists of peak tracking errors, MISSILE1 status, plot output, and debug output.

The model was developed in 1985.

CATEGORY: 2

ACRONYM: SGR

NAME: Sortie Generation Rate

PURPOSE: To estimate the number of sorties per aircraft per day that can be generated by the aircraft at a base.

ENTRY No(s): 2-70

MODEL DATA: 700 GPSS-V statements

DESCRIPTION: SGR is applicable to any aircraft program and measures sortie generation rate as a function of major aircraft design parameters, base operations scenario, and the maintenance and supply support system. The model is intended for use in the conceptual and early design phases of a program and operates on summary-level input parameters.

Maintenance activities considered are scheduled maintenance, unscheduled maintenance, and combat damage. Alternatives to accommodating stockouts of spare LRUs include expedited base repair of a failed LRU, expedited resupply of an LRU to the base, and cannibalization.

Other features include evaluation of nuclear biological chemical (NBC) conditions, exterior versus interior maintenance access, maintenance team queueing, and breakdown of maintenance actions into airframe, propulsion and avionics.

The model was developed in 1984.

CATEGORY: 2

ACRONYM: SPEED

NAME: Simulation of Penetrators Encountering Extensive Defenses

PURPOSE: To represent the penetration of air defense structure over an extended geographic region.

ENTRY No(s): 2-67

MODEL DATA: Fortran; DEC VAX 11/780

DESCRIPTION: SPEED is a one sided, event based, stochastic, many on many campaign simulation that models of the interactions between forces and elements of a defense. The model is supported by the output of a variety of other one on one models, such as POOL and TAC ZINGER. SPEED consists of five submodels which execute faster than real time due to the input data structure.

Input includes penetrator flightpaths, air defense system composition, weapon target designation, and effectiveness tables.

The output consists of summary statistics and more detailed outputs as desired.

CATEGORY: 2

ACRONYM: TAC ASSESSOR

NAME: TAC ASSESSOR

PURPOSE: To analyze tactical C3I and reconnaissance related issues.

ENTRY No(s): 2-73

MODEL DATA: Fortran; IBM 3032; CDC Cyber; DEC VAX

DESCRIPTION: TAC ASSESSOR is a two sided, combined arms, event sequenced simulation model with emphasis on C3I activities relating to air and ground tactical interaction.

The model simulates a Corps area of operations. Air operations include tactical reconnaissance, close air support, battlefield interdiction, and defense suppression missions. Aircraft are modeled as flights and ground units are modeled at the battalion unit level. C3I elements are modeled with decisions and intelligence processes using artificial intelligence techniques.

TAC ASSESSOR does not model weather, nuclear or chemical operations, or air to air engagements. It does not have a detailed communications module or a sensor model that explicitly models SIGINT sensors.

Inputs to the model include scenario data, initial orders for air and ground headquarters, air and ground unit characteristics, aircraft and weapons performance data, C3I structure, sensor performance data, ground weapons effectiveness data, and inputs to artificial intelligence routines.

The model produces extensive output data.

CATEGORY: 2

ACRONYM: TAC AVENGER

NAME: TActical Capabilities, AVionics, ENerGy-maneuverability Evaluation and Research

PURPOSE: To simulate a close-in maneuvering air duel between two aircraft.

ENTRY No(s): 2-74

MODEL DATA: Fortran; Honeywell 635; IBM 3032

DESCRIPTION: TAC AVENGER is a digital computer simulation of two aircraft in a close-in maneuvering air duel. Each aircraft maneuvers in three dimensions, each pilot reacts on a second by second basis to the maneuvers of the opponent, and each pilot expends ordnance against the other aircraft as opportunities occur. The individual aircraft tactics are selected from a range of reasonable choices based upon the tactical situation.

The relative performance capability of the aircraft and pilot preferences were derived from empirical, real world data and are selected using a random selection of avionics, energy maneuverability, and weapons to figure effectiveness.

Input is in the form of detailed engineering data.

Output includes aircraft position, missile/target position, gun/target, and missile/gun summaries.

CATEGORY: 2

ACRONYM: TAC BRAWLER

NAME: TAC BRAWLER

PURPOSE: To model multiple aircraft air combat

ENTRY No(s): 2-75

MODEL DATA: Fortran and PL/I; Honeywell 645

DESCRIPTION: TAC BRAWLER is a Monte Carlo, event driven computer simulation of flight versus flight air combat.

Inherent within the simulation is the explicit modeling of the human decision processes through the use of "value driven," "decision making," and "information oriented decision architecture."

Special emphasis has been placed on simulating cooperative tactics and on capturing the importance of situational awareness in both the visual and beyond visual range arenas.

The model configuration supports the simulation of engagements of up to sixteen total aircraft; up to twelve on one side; up to four flights; and up to eight aircraft in a flight.

TAC BRAWLER is in its sixth phase of development which will add unique tactics, ECM, COMJAM, and GCI capabilities.

Inputs include force sizes and starting conditions, armament and fuel loads, and specific tactics if desired.

Output consists of a summary printout of important events and detailed graphical displays.

CATEGORY: 2

ACRONYM: TAC DISRUPTER

NAME: TAC DISRUPTER

PURPOSE: To examine interactions between air forces and SAM/AAA air defense systems.

ENTRY No(s): 2-76

MODEL DATA: Fortran and Simscript; VAX 11/730; IBM

DESCRIPTION: TAC DISRUPTER is a time driven, deterministic which models the interactions between strike forces and integrated air defense networks. Strike forces may consist of battlefield interdiction, close air support, strategic penetrator and support aircraft.

Each simulation covers a time period which can be specified by the analyst or imposed through the use of actual field test flight path data. Time is stepped in one second increments. Current and future events are generated at each time increment based on the situation as perceived by each player.

TAC DISRUPTER can be used to model specific combat situations and analyze the effects of different combinations of air to ground attack strategies and ground defense configurations.

The command and control structures of integrated air defense networks is explicitly modeled. All detections, target assignments, and message traffic are modeled explicitly. TAC DISRUPTER also models the effects of ammunition limits and reload times extending to divisional depot level resupply.

Input requirements include target arrays, weapon system data, offensive and defensive procedures and doctrine, ingress and egress checkpoints, ECM equipment parameters, RCS, IR signature, antenna patterns, lethality, and SAM netting.

The model has extensive output capability.

The model was originally developed in the early 1960's and has been extensively modified and expanded.

CATEGORY: 2

ACRONYM: TAC EVALUATOR

NAME: TAC EVALUATOR

PURPOSE: To show the effect of various combinations of tactical air weapons and support systems on the outcome of a dynamic, corps level ground battle.

ENTRY No(s): 2-77

MODEL DATA: Fortran; Honeywell 6180; CDC Cyber 74

DESCRIPTION: TAC EVALUATOR is an event sequenced, expected value simulation. Lanchester equation algorithms resolve the ground combat engagements. The model simulates breakthrough tactics; single, double, and vertical envelopments; and employment of tactical air. It contains functional modules for reconnaissance or C3 simulation, including communications jamming.

The model keeps track of movement, strength, and attrition of up to 200 ground units including both engaged and second echelon units. It generates close air support and interdiction mission demand, allocates available aircraft in either interactive or automatic mode, performs targeting, and computes aggregate strike results and air losses. Offensive unit movement is simulated at engaged or approach march velocities with delays in movement of ground forces as a result of air strikes.

The model also tracks ground unit combat situations and tactical airpower decisions at tactical control facilities and below. When specified, emulations of communications jammers interact with represented communications transmissions producing delay and disruption. These interactions influence aircraft sortie generation and the distribution of sorties over the battlefield.

The model has automatic and interactive modes.

Input data includes force size, reconnaissance plans, and weapons effectiveness data.

TAC EVALUATOR contains an extensive graphics package for output.

CATEGORY: 2

ACRONYM: TAC LANCER

NAME: TAC LANCER

PURPOSE: To evaluate the effectiveness of air to air missiles in maneuvering combat.

ENTRY No(s): 2-78

MODEL DATA: Fortran; IBM 3081

DESCRIPTION: TAC LANCER was developed to provide endgame missile effects for the TAC AVENGER model. The model can be used both online with TAC AVENGER and offline to assess missile capabilities. It provides missile probability of kill in a maneuvering environment. The simulation includes fusing and fragment impact, and launch, guidance, and fuse reliability factors.

Input consists of detailed engineering data.

Output is in the form of missile/target position and terminal effects summaries.

The model was developed in 1977.

CATEGORY: 2

ACRONYM: TAC PROTECTOR

NAME: TAC PROTECTOR

PURPOSE: To perform analysis and change assessments of the effects of aircraft self protection capability mixes on aircraft attrition and bombs on target.

ENTRY No(s): 2-79

MODEL DATA: Basic; Zenith Z-100/150

DESCRIPTION: TAC PROTECTOR is a deterministic, simple rate model tracking friendly aircraft and hostile air defense unit attrition. The model simulates few on few engagements. Statistics are compiled on a sortie by sortie basis.

Inputs include self protection capability mix and parameters, ingress and egress altitude and flight size, and limited scenario variations.

Output consists of aircraft or air defense unit attrition, cumulative sorties flown and cumulative bombs on target, all on a daily basis.

The model was developed in 1985.

CATEGORY: 2

ACRONYM: TAC REPELLER

NAME: TAC REPELLER

PURPOSE: To investigate aircraft attrition due to ground based air defense systems, including radar and IR guided SAMs, and air defense artillery.

ENTRY No(s): 2-80

MODEL DATA: Fortran; Honeywell MULTICS; IBM 3032; CDC Cyber 176

DESCRIPTION: TAC REPELLER is an event and time stepped, two sided, Monte Carlo, combat simulation model that treats interactions between aircraft and individual component units of an integrated air defense array. It simulates few on few engagements in detail.

Processes modeled include aircraft movement, threat detection and prioritization, target selection by defensive units, target engagement, and defense suppression. Outcomes of individual engagements within the few on few scenario are determined by invoking detailed one on one engagement models such as TAC ZINGER and POOL.

Aircraft movement is on prescribed flight paths. Detection of aircraft by radar and visual means is modeled. Radar detection is based on a form of the radar range equation. Countermeasures equipment (jammers and flares) carried by aircraft may affect both initial detection and target tracking.

The model does not represent weather, obscurants, or communications jamming. Also, coordinated radar jamming is not included.

Input includes aircraft characteristics; position data for radars and fire units; individual aircraft flight paths, position, velocity, and orientation; detection radar parameters; terrain data; threat prioritization and target selection parameters; command structure; ammunition stocks and reload times; jammer characteristics; and mission data.

Output consists of a time history for individual aircraft.

CATEGORY: 2

ACRONYM: TAC SUPPRESSOR

NAME: TAC SUPPRESSOR

PURPOSE: To address air defense and defense suppression problems in scenarios larger than one versus one but smaller than theater level.

ENTRY No(s): 2-81

MODEL DATA: Fortran; IBM 370; IBM 3330; VAX 11/780

DESCRIPTION: TAC SUPPRESSOR is an event stepped simulation model designed to evaluate the effectiveness of air and land weapon systems, jamming systems, tactics, and command and control procedures. Element of the simulation are defined by attributes, allowing a variety of types of forces to be modeled. Naval warfare can be simulated by defining elements with the attributes of various types of ships.

Strike forces are represented as aircraft flying preplanned and reactive flight paths. Preplanned flight paths are used for aircraft designated to attack known target locations. The reactive mode of the model allows aircraft to engage targets of opportunity using tactical guidelines provided as input. Air defenses are represented by early warning sites, command centers, and fire units.

All units are capable of autonomous operations, as well as varied modes of echelon control. Threat prioritization, weapon assignment, and other air defense functions are modeled. Missile intercept is calculated using target flight path and relative geometry. Engagement results are provided by table look-up.

Input data includes equipment characteristics and attributes, chains of command, communications networks, tactics, and doctrine.

Output is in the form of statistics tables in various formats.

The model was developed in 1981 and updated in 1984.

CATEGORY: 2

ACRONYM: TSARINA

NAME: TSAR INputs using Aida

PURPOSE: To evaluate chemical and conventional attack against air bases.

ENTRY No(s): 2-83 through 2-85

MODEL DATA: 6,000 Fortran statements; VAX 11/780; IBM 3081

DESCRIPTION: TSARINA is the latest version of an adaptation of the Airbase Damage Assessment (AIDA) computer model. This version has been developed to simulate airbase attacks with chemical weapons and to generate more detailed damage data for conventional attacks.

TSARINA is a Monte Carlo model. It permits assessments to be developed for a campaign of air attacks, and prepares those assessments for the Theater Simulation of Airbase Resources (TSAR) model to assess the impact of the destructive and disruptive effects of conventional and chemical attacks on sortie generation.

In the first version of TSARINA several key additions were made to the Aida Model so that the on-base location of resources can be readily associated with various targets, different mean area of effectiveness of kill probabilities can be defined for the different resources, and a novel two-level 'cookie cutter' can be used to represent the effectiveness of weapons against the various classes of resources.

TSARINA, as presently configured, permits damage assessments of an airbase complex that is composed of up to 750 individual targets and 2500 packets of resources. The targets may be grouped into as many as 30 different vulnerability categories, and different types of personnel, equipment, munitions, spare parts, TRAP (tanks, racks, adaptors, and pylons), building materials, and POL (petroleum, oils, and lubricants) can be distinguished. The attacks may involve as many as 100 weapon-delivery passes and 10 types of weapons.

ACRONYM: TSARINA

DESCRIPTION: (continued)

Input includes control data TSAR data, chemical weapon data, special features, target data, target height, resource equivalence, attack data, alternate attack data, effective miss distance, submunitions pattern, multiple MCL data and mobile arresting barrier data.

Output data includes effects of conventional and chemical weapons for each trial, damage data for specified resources for TSAR, and multi-trial damage statistics for specified resources, and plot of impacts and minimum operating surface on flight surfaces.

The model was developed in 1985.

CATEGORY: 2

ACRONYM: VECTOR

NAME: VECTOR

PURPOSE: For use in estimating net assessments, performing force deployment studies, and providing information for performing trade offs among weapon systems.

ENTRY No(s): 2-86

MODEL DATA: Fortran; Univac 1100/82; Amdahl 590

DESCRIPTION: VECTOR is a two sided, deterministic simulation of integrated air and land combat. Aggregation level is the maneuver battalion or its equivalent. The model has generally been applied to corps level scenarios, although it can be applied at a theater level.

The model uses difference equations to compute movement, detection, and attrition results. Time step sizes appropriate to the individual process are used. Asynchronous events are also handled. Tactical decision rules are provided as input.

The model allows seven maneuver unit weapon systems per side, and weapons types of tactical aircraft, artillery, air defense artillery systems, mines, helicopters, and aircraft shelters.

Input requirement include force composition and location; tactics data and tactical rules; weapons, personnel, equipment, and supplies; weather data; battlefield description, terrain, geography, and lines of communications network; and performance data.

Output consists of unit and inventory information, losses and exchange ratios, FEBA movement, target and intelligence information, and other statistical data.

The most recent version of the model is VECTOR-3, which was developed in 1982.

Jordan and Associates

AF88-092 Phase I

SYSTEM/SUBSYSTEM PERFORMANCE MODELS

<u>Acronym</u>	<u>Name</u>
ADAM	Automatic Dynamic Aircraft Model
AEP	Avionics Evaluation Program
(AFPP)	Aircraft Flight Procedures Program
AIRCRA	
CRKGRO	Crack Growth
DYSCO	Dynamic System Coupling
EASY-ACLS	Environmental-Control Analysis System - Air Cushion Landing System
FATOLA	Flexible Aircraft Take-Off and Landing Analysis
FLOPS	Flight Optimization System
GASP	General Aviation Synthesis Program
HAVE BOUNCE	
MIREM	Mission Reliability Model
(MRMC)	Mission Radius and Maneuverability Characteristics
NORTAX	
OMENS	Opportunistic Maintenance Engine Simulation
SAIFE	Structural Area Inspection Frequency Evaluation
SESAME	System of Equations for the Simulation of Aircraft in a Modular Environment
SKI JUMP	
STRAT SPLASH	
TAC RANGER	
VALT	VTOL Approach and Landing Technology
VASCOMP	V/STOL Aircraft Sizing and Performance Computer Program

CATEGORY: 3

ACRONYM: ADAM

NAME: Automatic Dynamic Aircraft Model

PURPOSE: To generate NASA Structural Analysis (NASTRAN) Structural models with minimal data or knowledge.

ENTRY No(s): 3-12

MODEL DATA: Fortran

DESCRIPTION: The model generated by ADAM includes the executive, case control, and bulk data decks. The model is set up for eigenvalue analysis with the appropriate plotting commands.

Input is in four groups. Group A states the number and type of components. Group B contains all body data. Group C contains all wing data. Group D contains concentrated point mass data. Group B and C has structural and non-structural distributed panel/rod mass data.

Output consists of a NASTRAN model designed for normal modes analysis. A plot file is automatically generated so that the first ten eigenvectors or modeshapes can be plotted. A summary table of the input with user warning messages and a card count are on another file.

The model was developed in 1985.

CATEGORY: 3

ACRONYM: AEP

NAME: Avionics Evaluation Program

PURPOSE: To perform effectiveness evaluation of avionics for military aircraft

ENTRY No(s): 3-13 and 3-14

MODEL DATA: Fortran

DESCRIPTION: AEP is a library of seven detailed avionics performance assessment models driven by a common, interactive software package. It provides an efficient means for performing tradeoff analyses among cost, reliability, maintainability, and performance of avionic configurations.

The models are the air to ground mission analysis program, target acquisition, weapon delivery, survivability, communications, air to air mission analysis, and dogfight analysis.

The original AEP was developed to provide the Air Force Avionics Laboratory with an efficient tool for conducting in-house analyses of current and postulated weapon system concepts performing air-to-ground missions in a wide spectrum of operational environments.

An interactive graphics capability was later added to provide much more efficient use of the program.

An improved version of the AEP that incorporates imperfect equipment monitoring, multiple aircraft, multiple sorties, and cost accumulation; updates the interactive graphics processor; includes a more easily used technique for accessing hardware and function data; and has additional features for displaying output results followed.

As part of the input data, the user must describe the equipment list that makes up an aircraft. The user has flexibility to aggregate or disaggregate actual 'black boxes' into equipment elements.

ACRONYM: AEP

DESCRIPTION: (continued)

Other input includes: hardware subfunction data; subfunction hardware complement; flight profile; weapon delivery; target acquisition; permanent file input data storage data - AEP execution lists; hardware/subfunction data; flight profile; weapon delivery execution lists; weapon delivery error sources; weapon delivery aircraft; MARSAM execution lists; and MARSAM candidate data.

The results of the simulation are stored as a permanent file and accessed via the AEP interactive program.

The output is composed of statistics describing random variables, number of occurrences of random events, and function/subfunction utilization.

The model was developed in 1972.

CATEGORY: 3

ACRONYM: (AFPP)

NAME: Aircraft Flight Procedures Program

PURPOSE: To construct aircraft flight paths and performance schedules.

ENTRY No(s): 3-02 and 3-03

MODEL DATA: Fortran; IBM 370/168MP

DESCRIPTION: The Aircraft Flight Procedures Model is used to construct aircraft flight paths and performance schedules for specified operational procedures.

The computer model algorithms were derived from fundamental aircraft and engine performance relationships or from operational characteristics applicable to specific aircraft types.

The program was developed in 1981.

CATEGORY: 3

ACRONYM: AIRCRA

NAME: AIRCRA

PURPOSE: To evaluate relative combat aircraft performance.

ENTRY No(s): 3-15

MODEL DATA: Fortran

DESCRIPTION: AIRCRA is a suite of FORTRAN-IV computer programs which may be used to assist in evaluating relative combat aircraft performance, using energy maneuverability theory.

The programs include executive routines; a main calculation program; configuration, thrust, and drag data subprograms for each aircraft type; input/output programs, including graphics routines; and data libraries.

The model was developed in 1982 by the Aeronautical Research Lab in Melbourne, Australia.

CATEGORY: 3

ACRONYM: CRKGRO

NAME: CRACK GROWTH

PURPOSE: To perform detailed fatigue crack growth analysis on a cycle-by-cycle basis.

ENTRY No(s): 3-21

MODEL DATA: Fortran

DESCRIPTION: CRKGRO is a two-dimensional crack-growth computer routine. An improved load interaction model which accounts for both the retardation and acceleration effects of the spectrum loading was implemented in the program.

The program contains a crack library which consists of 10 subroutines, each containing a specific stress intensity factor solution for a specific crack geometry. There are eight additional dummy routines stored in the program, which provide the capability for adding new stress intensity factor solutions for the crack geometries to be considered.

Input data include: crack depth over crack length ratio, crack depth over thickness ratio, crack depth, stress intensity factor solution in depth direction, crack length, stress intensity factor solution in length direction, half width of structure, shape factor, radius of hole, thickness, structure geometry and load interaction effects.

The output consists of input echo data and computed results. The latter can be classified as either graphical displays or tabular displays. Various levels of displays are provided for growth history data which exhibit a large quantity of information.

The model was developed in 1981.

CATEGORY: 3

ACRONYM: DYSCO

NAME: DYNAMIC System COUpling

PURPOSE: To analyze rotorcraft dynamic and aerodynamic phenomena based upon coupling independent, arbitrary component representations into a valid representation of a complete system.

ENTRY No(s): 3-23

MODEL DATA: Fortran; IBM 4341.

DESCRIPTION: The DYSCO program includes a library of component representations, applied force algorithms, and solution methods.

The user specifies a set of components and selects an appropriate force algorithm for each component and supplies the necessary data. DYSCO defines the control logic for definition of the equations of motion of the coupled dynamic system, then the user selects a solution method, and DYSCO forms the equations and carries out the solution.

The equations are sets of second-order ordinary differential equations. The coefficients and forces may be nonlinear and time dependent. The solutions may be in the time or frequency domain.

The user must formulate a model of the vehicle or structure in terms of the available component and force representations, have available the appropriate input data for each of the modules, select an appropriate solution technology module, and define the necessary data to control the solution process.

The model was developed in 1982.

CATEGORY:

3

ACRONYM:

EASY-ACLS

NAME:

Environmental-control Analysis System - Air Cushion
Landing System

PURPOSE:

To assist in the development of improved control
systems.

ENTRY No(s):

3-24

MODEL DATA:

Fortran

DESCRIPTION:

The EASY model consists of two programs, a model
generation program and a model analysis program,
which allows a wide variety of dynamic systems to
be modeled and analyzed as to either their steady
state or dynamic behavior.

In the EASY program, a user defines the system to
be analyzed by specifying the individual components
and their interconnections. Each component is
simulated in a subroutine of the main program, and
each has input data requirements which must be
supplied by the user. Twenty-two components are
modeled, such as:

- Air Bag Skid System
- Simple Duct
- Valve in a Duct
- Inlet Fan
- Switches (4 types)

There is also a set of standard subroutines and
functions which are called automatically as they
are required, and for which the user need not
supply any input data.

The model was developed in 1979.

CATEGORY: 3

ACRONYM: FATOLA

NAME: Flexible Aircraft Take-Off and Landing Analysis

PURPOSE: To simulate the dynamics of conventional aircraft during takeoffs and landings.

ENTRY No(s): 3-31

MODEL DATA: Fortran

DESCRIPTION: Program TOLA (Take-off and Landing Analysis) provides a non real time simulation of the dynamics of conventional aircraft during takeoffs and landings.

The program models the performance of an aircraft during a takeoff roll or during the glide slope, flare, impact, and rollout of a landing. It includes the effects of a number of external and internal conditions such as wind shears, rough runway, engine failure, ground effect, etc.

TOLA was modified to include a flexible airframe option and is identified as program FATOLA at NASA Langley.

A provision for actively controlled landing gear has been incorporated. The active control code simulates dynamic load control during impact and rollout, and during takeoff roll on rough runways. Additionally, a program restart capability was added as well as other program enhancements.

The program was developed in 1972.

CATEGORY: 3
ACRONYM: FLOPS
NAME: FLight OPTimization System
PURPOSE: To optimize aircraft configuration.
ENTRY No(s): 3-41
MODEL DATA: Fortran
DESCRIPTION: FLOPS is an aircraft configuration optimization program developed for use in conceptual design of new aircraft and in the assessment of the impact of advanced technology.

The program contains modules for preliminary weights estimation, preliminary aerodynamics, detailed mission performance, takeoff and landing, and execution control.

An optimization module is used to drive the overall design and in defining optimized profiles in the mission performance. Propulsion data, usually received from engine manufacturers, are used in both the mission performance and the takeoff and landing analyses.

Although executed as a single in-core program, the modules are stored separately so that the user may select the appropriate modules (e.g., fighter weights versus transport weights) or leave out modules that are not needed.

CATEGORY: 3

ACRONYM: GASP

NAME: General Aviation Synthesis Program

PURPOSE: To perform tasks associated with the preliminary design of general aviation aircraft.

ENTRY No(s): 3-27

MODEL DATA: 13,000 Fortran statements; CYBER 170 series.

DESCRIPTION: GASP was developed to perform tasks generally associated with the preliminary design phase of small, fixed wing aircraft employing propulsion systems. It provides the capability to perform parametric studies in a rapid manner during preliminary design efforts.

The system consists of an executive driver and eight basic computer programs, which are used to build up the force coefficients of a selected configuration. The system employs modified linearized theory methods for the calculation of surface pressures and supersonic area rule concepts, in combination with linearized theory, for the calculation of aerodynamic force coefficients.

The executive driver invokes individual modules to provide the data and computations required for configuration design or analysis.

In one module, skin friction is computed using turbulent flat plate theory. Wave drag is calculated in either the far-field (supersonic area rule) module or the near-field (surface pressure integration) module.

The far-field module is used for wave drag coefficient calculations and for fuselage optimization according to area rule concepts.

The near-field module is used primarily as an analysis tool, where detailed pressure distributions are of interest.

ACRONYM: GASP

DESCRIPTION: (continued)

Lifting pressures, drag-due-to-lift, pitching moment, and trim drag are computed by the lift analysis module, which divides the components of the configuration into a mosaic of 'Mach-box' rectilinear elements which are employed in obtaining linear theory solutions.

A complementary wing design and optimization module computes the wing shape required to support an optimized pressure distribution at a specified flight condition.

A geometry module handles configuration geometry for the system. The user prepares only "drawing type" geometry data; all "paneling" of the configuration for theoretical analyses is handled by the system.

The wing pressure module summarizes and tabulates for output the wing surface pressure data for user-specified conditions.

A plot module draws configuration pictures according to user specified size and view parameters.

This program was developed in 1980.

CATEGORY: 3

ACRONYM: HAVE BOUNCE

NAME: HAVE BOUNCE

PURPOSE: To perform analyses to determine the response of the F-15 to landing and taxi over rapidly repaired bomb damaged runways.

ENTRY No(s): 3-29

MODEL DATA: 2,500 Fortran statements

DESCRIPTION: The program uses either a simulated or measured runway roughness profile to excite an aircraft model and generate landing gear load and airframe response analytical data. Both actual loads and percent of design limit values are calculated.

A data base is provided to simulate a typical F-15 aircraft and various runway roughness repairs. The program is compatible with FORTRAN-V language and can be executed interactively or in batch mode.

Input data include: simulation option; aircraft pitch attitude; change data base parameters; RDT matrix member and value; distance in front of profile; aircraft configuration; aircraft properties; sink speed, head wind; taxi speed; speed increment; number of increments; tire pressure code; runway profile definition; bump/dip characteristics; gear symmetry; number of symmetrical and asymmetrical aircraft modes; flexible model configuration; thrust; and final time.

Output data consists of time histories and maximum summaries of selected parameters.

CATEGORY: 3

ACRONYM: MIREM

NAME: Mission RELiability Model

PURPOSE: To evaluate mission reliability and sustained operating capability of advanced electronic systems during the early development phase.

ENTRY No(s): 3-34

MODEL DATA: Fortran; VAX 11/780.

DESCRIPTION: Typical reliability analyses that can be conducted using MIREM include:

- evaluations of mission reliability for alternative mission scenarios;
- determination of the additional operating time without repair that can be achieved due to fault tolerance;
- identification of the parts within a system that are contributing significantly to mission failures;
- identification of design improvements that offer a large payoff in mission reliability; and
- comparison of integrated, fault-tolerant systems with conventional discrete systems in terms of mission reliability.

An ancillary program called DATAIN performs the data entry function using online, user-friendly screens to create or update architecture files and scenario files. MIREM reads these files to perform computations, prepares reports dealing with fault-tolerant system reliability, and creates a plot file containing the selected plots.

Input data include structural data describing which system resources are required to perform each operational function and how these functions interact in their use of resources, and reliability and maintainability data for each resource identified in the structural data.

Output includes mission completion success probability, budget, mean time between critical failure, mean time between function failure, line replaceable module/line replaceable unit budget, repair policy, and testability factors.

The model was developed in 1986.

CATEGORY: 3

ACRONYM: (MRMC)

NAME: Mission Radius and Maneuverability Characteristics

PURPOSE: To perform detailed analysis of the mission radius and maneuverability characteristics of combat type aircraft.

ENTRY No(s): 3-33

MODEL DATA: 5,500 Fortran statements; CYBER 70 series.

DESCRIPTION: The program was developed with the assumption that great emphasis would be placed on balanced-radius profiles, and that alternate radius missions would be of interest as trade-off information. Thus, it was designed to produce accurate performance results for all mission segments while minimizing the repetitive calculations normally required to balance radii and develop radius trades.

The program contains five mission modules. Each mission module is designed to determine the combat radius or range capability for a specific mission with its associated ground rules and profile definitions. Several of these mission profiles contain optional profile segments for use in representing alternate missions.

Input includes propulsion data, aerodynamic data, aircraft weight data, and mission requirements.

For each requested flight-point, an extensive set of aircraft state variables and acceleration rates are output.

This program was developed in 1981.

CATEGORY: 3

ACRONYM: NORTAX

NAME: NORTAX

PURPOSE: To provide rapid assessment of the structural capability of aircraft to perform operations on rough repaired or unpaved airfields.

ENTRY No(s): 3-28

MODEL DATA: 5,000 Fortran statements.

DESCRIPTION: NORTAX was developed to analyze the aircraft ground operation responses under various operating modes and surface conditions.

The program is capable of handling multiple aircraft types, landing gear types and detailed configurations, including the unsprung mass layout. It can generate time histories of loads and other responses of flexible aircraft structures while performing landing impact, taxiing, turning, and braking operations on paved, paved and bomb damage repaired, and unpaved yielding soil-surface runways.

Bogie dynamics and the trim cylinder influence are also considered in the program. A multispring tire model is available for runways with sharp edge bumps or short wavelength obstacles.

Input data includes logical data; aero and start-end data; geometry, physical locations and control data; turn-angle table; modal data; constants required in brake equations and brake torque table; hook force table; arrest-chute data; and piecewise linear description of runway profile shape.

Output data consists of time histories of key variables and a summary of the maximum and minimum extremes of the following responses; CG vertical acceleration, strut axial forces, vertical accelerations at selected stations on the fuselage or wing elastic axis, vertical, fore-aft, or lateral accelerations at control points on external stores or pylon-mounted engine nacelles, and shear loads, bending moments, and torsional moments at selected wing sections.

The model was developed in 1985.

CATEGORY: 3

ACRONYM: OMENS

NAME: Opportunistic Maintenance Engine Simulation

PURPOSE: To simulate the operation of a single engine through a long period of time.

ENTRY No(s): 3-36

MODEL DATA: 2,200 Fortran statements; Honeywell 635.

DESCRIPTION: The model provides long-run forecasts of engine and module removals caused by failure as well as time expiration and opportunistic replacement of the internal life-limited parts.

It also calculates composite (usage, scheduled, and screened) engine removals per 1000 flying hours factors and their corresponding NRTS (Not Reparable This Station) rate factors.

These forecasts are based on input failure rates, maximum operating time limits, and screening intervals for the opportunistic maintenance policy.

The model can also be used to estimate the expected effectiveness of alternate screening intervals.

There are several versions of the model.

- OMENS I was written for the F100 PW100 engine installed in the F-15 aircraft.
- OMENS II is an improved version incorporating transportation costs and OMENS III is a further refinement.
- OMENS IV and V were written for the F100/200 engine.
- There is also a general version, OMENS XXX.

Operationally, the model simulates the operation of a single engine through a very long period of future time. In operating over this extended period, the engine must be removed for repair from time to time.

Repairs become necessary on the engine when one of the modules fails prematurely or whenever it requires replacement of an internal life-limited part.

ACRONYM: OMENS

DESCRIPTION: (continued)

The model tracks all the engine removals and all replacements of each module and offending life limited part through simulated time. Records are kept through simulated time of the number of removals and the reasons for removal for each module and for the engine.

Reasons for removal include premature failure of one or more parts, reaching the scheduled operating time limit, or being screened out due to the opportunistic maintenance policy.

The model also computes maintenance, pipeline, parts costs, and transportation costs associated with the forecasted removals and aggregates the costs for any desired life cycle period (in years) to aid in selecting that optimal maintenance policy which produces the least total cost.

Actuarial, pipeline, and cost data, including initial NRTS rates, are internal data needed to run the program. These values are defined in the design maintenance concept.

There is also variable data involved in running the model. This data is user input and can be changed to simulate different program policies and the effects on cost. These values include the screening variables, number of runs desired, life cycle and simulation years chosen by the user.

The output data of the model is broken into several different sections. There are tables which show engine and module report period summary removals, NRTS rates, parts replacements costs, depot and base costs, and an objective function which ties all the replacements and removals together with a cost analysis table for a given life cycle. There are two different screening values that must be entered for each part, a base screen value and a depot screen value.

The model was originally developed in 1979 by AFLC.

CATEGORY: 3

ACRONYM: SAIFE

NAME: Structural Area Inspection Frequency Evaluation

PURPOSE: To simulate the structural performance of an aircraft fleet and the effectiveness of an inspection program.

ENTRY No(s): 3-45

MODEL DATA: Simscript II.5

DESCRIPTION: SAIRE is a large, complex mathematical model, containing a number of submodels.

The aircraft model is divided into structurally significant elements and the inspection program for each element is defined.

Structural defects are classified as: fatigue and corrosion which are wear-out and aging phenomena; production or design defects; and operational or maintenance damage. These defects and the inspection program are treated as probabilistic phenomena interacting over time.

The program input consists of three parts: variables which pertain to the aircraft type under consideration; alternative output format if standard output is not used; and input variables whose values are unique to each element.

For each element simulated, SAIFE generates the number of defects - cracks, corrosion, service damage, and production damage - that occur during the service life of the aircraft. Except for production damage, the minimum, maximum, and average flight hours at which the defects occur are also presented.

Other output includes the number of cracks and corroded areas detected, flight hour and aircraft identification information.

The model was developed in 1978.

CATEGORY: 3

ACRONYM: SESAME

NAME: System of Equations for the Simulation of Aircraft
in a Modular Environment

PURPOSE: To simulate aircraft motion in real time.

ENTRY No(s): 3-39

MODEL DATA: 20,000 Fortran statements

DESCRIPTION: SESAME is a system of equations for the simulation
of an aircraft's "rigid-body" motion in real time
using a digital computer.

Those parts of the mathematical model which are common to all aircraft, such as the equations of motion and axis transformations, have been created as a set of standard modules, leaving the user to create only a small group of routines specifically to describe his aircraft. The two sets of modules are then linked together to produce a complete model program.

CATEGORY: 3

ACRONYM: SKI JUMP

NAME: SKI JUMP

PURPOSE: To study the feasibility of using ramp assisted takeoff for conventional takeoff and landing aircraft.

ENTRY No(s): 3-22

MODEL DATA: Fortran; CDC 6600.

DESCRIPTION: SKI JUMP includes three degrees of freedom (longitudinal and vertical translation and pitch rotation) for the aircraft with additional degrees of freedom for each landing gear strut, non-linear aerodynamic and thrust characteristics, control system dynamics and simulated pilot control functions. Runway boundary conditions and ramp geometry are modeled in a general sense and must be quantified by the user.

Input data include: description of aircraft, aerodynamics of the aircraft, geometry of runway, and geometry of take-off ramp (ski jump).

Output data consists of a repeat of input for reference, tabular time history data, a summary of minimum/maximum parameter values, and a plot data file.

The model was developed in 1983.

CATEGORY: 3

ACRONYM: STRAT SPLASH

NAME: STRAT SPLASH

PURPOSE: To simulate the air-to-air missile environment.

ENTRY No(s): 3-44

MODEL DATA: FORTRAN

DESCRIPTION: The STRAT SPLASH model enables the user to estimate the single shot probability of kill for air-to-air missiles. While the missile aerodynamics for a significant portion of the model, the distinctive feature is the capability to estimate the effect of noise or deception ECM on missile guidance.

The model incorporates an Army Materiel Systems Analysis Activity terminal effects model to evaluate the interaction of warhead lethality and target vulnerability.

Input includes aircraft launch parameters, missile aerodynamic characteristics, warhead, and guidance parameters.

The output consists of missile flyout and warhead interaction.

CATEGORY: 3

ACRONYM: TAC RANGER

NAME: TAC RANGER

PURPOSE: To conduct combat range/radius and payload tradeoff studies.

ENTRY No(s): 3-46

MODEL DATA: Fortran; IBM 3081

DESCRIPTION: The TAC RANGER computer program is used in fighter aircraft performance studies to establish range and payload for various combat missions.
Input consists of detailed aerodynamic descriptions of the aircraft, weapons load, and mission profiles.
The output includes aircraft time, weight, fuel, range, altitude, true airspeed, Mach, and fuel flow at turnpoints.
The model was developed in 1978 by Air Force Studies and Analysis.

CATEGORY: 3

ACRONYM: VALT

NAME: VTOL Approach and Landing Technology

PURPOSE: To integrate avionics research in navigation, guidance, controls, and displays with a realistic aircraft model.

ENTRY No(s): 3-48

MODEL DATA: 10,000 Fortran statements; CDC 6000 series.

DESCRIPTION: Various measurement sensors and avionics functions are represented by separate modules, allowing algorithms that are developed to be included into the simulation with minimal impact on the overall program structure. For each of the various modules, the user can select among the supplied models or add models as they are developed. The program currently includes a six-degree-of-freedom helicopter model.

VALT is composed of many independent modules that represent either specific hardware such as rate gyros, external navigational aids, or physical functions such as winds.

The helicopter model calculates and feeds back perfect signals, such as linear and angular velocities, positions, angles, and accelerations. The sensor models use as inputs the helicopter derived signals and generate appropriate output variables to represent the measurements. The user may select perfect measurement, where the output is equivalent to the input, or models with errors, where the output is a corrupted version of the input.

The outputs from the inertial measuring unit sensors feed into a navigation computer module. All of the measurement data is fed into an estimator module.

The guidance computer and external guidance commands consist of several modules. Guidance commands can be generated internally by stored nominal trajectory data and automatic guidance steering laws or by the pilot or by air traffic control.

ACRONYM: VALT

DESCRIPTION: (continued)

The guidance outputs generally represent some type of perturbation errors and are fed into the control computer. The control computer uses these commands to generate equivalent control stick commands.

The helicopter model consists of several modules. The main sections include actuator and rotor nonlinearities and dynamics, force and moment calculations, equations of motion, and an update section to calculate all of the variables that are fed to the sensor modules.

NAMELIST type data input is used and only the data associated with the particular simulation being run is required as input. This feature is accomplished by a series of defaults which the user can set to select modules for the overall simulation.

Output consists of time iterative listings of requested simulation variables over a particular time period for which initial conditions were given.

VALT was developed in 1977.

CATEGORY: 3

ACRONYM: VASCOMP

NAME: V/STOL Aircraft Sizing and performance COMputer Program

PURPOSE: To aid in the comparative design study for V/STOL aircraft systems by rapidly providing aircraft size and mission performance data.

ENTRY No(s): 3-49

MODEL DATA: 14,000 Fortran statements; CYBER 170 series

DESCRIPTION: VASCOMP2 can be used to define design requirements such as weight breakdown, required propulsive power, and physical dimensions of aircraft which are to meet specified mission requirements.

The program is also useful in sensitivity studies involving both design trade-offs and performance trade-offs. Generality and flexibility were maintained during formulation of the program in order to permit an accurate simulation of virtually any V/STOL configuration.

VASCOMP2 is capable of approximating the design process involved in the layout and sizing of a wide variety of V/STOL aircraft and synthesizing the performance of these aircraft.

The program is intended for use in the study of V/STOL aircraft which use fixed wing lift for primary cruise flight. The program is not suited for the study of aircraft which employ rotary wing lift for forward flight.

The VASCOMP2 program was developed in 1968 and last updated in 1980.

RELIABILITY - MAINTAINABILITY - SUPPORTABILITY
LOGISTICS - LIFE CYCLE COST
MODELS

<u>Acronym</u>	<u>Name</u>
AAM	Aircraft Availability Model
AMES	Aircraft Maintenance Effectiveness Simulation
AMSEC	Analytical Methodology for System Evaluation and Control
ARMS	Aircraft Reliability and Maintainability Simulation
ASM	Aircraft Sustainability Model
ASSCM	Avionics Software Support Cost Model
BRAT	Budget Readiness Analysis Technique
CORE	Cost Oriented Resource Estimating
DYNA-METRIC	Dynamic Multi-Echelon Technique for Recoverable Item Control
GOALS	General Operations and Logistics Simulation
ILSSM	Integrated Logistics Support Simulation Model
IREM	Incorporation of Readiness into Effectiveness Modeling
LCOM	Logistics Composite Model
MACATAK	Maintenance Capability Attack
MBSGM	Multi-Base Sortie Generation Model
METRIC	Multi-Echelon Technique for Recoverable Item Control
MLCCM	Modular Life Cycle Cost Model
MOD-METRIC	Modified Multi-Echelon Techniques For Recoverable Item Control
MOVES	Marine Operational V/STOL Environment Simulation
NAVMAN	
PLANET	Planned Logistics Analysis and Evaluation Technique
SAMSOM	Support Availability Multi-System Operations Model
SESAME	Selective Stockage for Availability, Multitechelon
SIMLOG	Simulation of Logistics

CATEGORY: 4

ACRONYM: AAM

NAME: Aircraft Availability Model

PURPOSE: To relate expenditures for the procurement and depot repair of recoverable spaces to aircraft availability rates, by weapon system.

ENTRY No(s): 4-01 through 4-04

MODEL DATA: Fortran

DESCRIPTION: The AAM is an analytical model based on economic and probabilistic concepts. It produces curves of expenditure versus availability rate for different aircraft types.

An aircraft is available if it is not awaiting completion of a resupply action. Other events, such as lack of consumable spares and required on-aircraft maintenance, may also prevent an aircraft from performing a mission; so the availability rate computed in the AAM is not a complete measure of readiness.

The AAM uses a marginal analysis technique, i.e., it ranks the candidates for procurement and repair in decreasing order of benefit per cost to form an ordered "shopping list."

Buying and repairing from this list in the order indicated assures that items which give the greater increase in availability rate per dollar (of procurement cost or repair cost, as appropriate) will be acquired earlier. Thus, the AAM optimizes aircraft availability for any funding constraint and produces optimum shopping lists and optimum repair strategies, by component, for funding level.

For application to Air Staff POM and Budget formulations, the data inputs to the AAM are almost identical to those used by the AFLC in its recoverable spares requirements computation.

The AAM was designed to use existing data bases to avoid the effort required to construct specially tailored data bases. The data used by the AAM are found in the AFLC D041 data base.

ACRONYM: AAM

DESCRIPTION: (continued)

Aircraft population and flying hour programs are supplied from Air Force planning documents, from either the AFLC K004 (Projected Programs) System or the PA (Aerospace Vehicles and Flying Hour Programs) System.

The AAM produces curves of cost versus availability rate for each aircraft type. Each point on the curves corresponds to an optimum procurement/depot repair plan.

The curves enable logistics planners to see the consequences of various allocations of available funds for procurement and repair among different aircraft types and to make informed tradeoffs among those allocations.

The curves may be used in two different, but complimentary, ways. Given established availability targets by aircraft type, the funds necessary to achieve those targets can be read from the curves. Conversely, the availability rates resulting from a specific allocation of funds to aircraft types can be obtained.

Associated with the model are reports of various formats and automated interactive programs. Advisory shopping lists and repair plans can be generated by item for a specific allocation.

The model was developed in 1983 by the Logistics Management Institute. A companion program, The Aircraft Sustainability Model (ASM) was developed in 1987 as part of an effort to improve the AAM model.

CATEGORY:

4

ACRONYM:

AMES

NAME:

Aircraft Maintenance Effectiveness Simulation

PURPOSE:

To study the relationship between maintenance and system performance of carrier based aircraft.

ENTRY No(s):

4-07

MODEL DATA:

Simscrip II.5

DESCRIPTION:

AMES is a dynamic representation of the maintenance and operation of a carrier based squadron of naval aircraft. It can be divided into several segments, each of which represents a corresponding segment of the system. The detail with which a given segment is represented depends upon the interest of that segment to the objectives of AMES.

AMES is different from other aircraft models in that it measures the effects of human errors in maintenance (maintenance accuracy). It can be used to identify those aspects of maintenance with large payoffs for improving operational readiness and/or mission completion rate. It can also be used to evaluate quantitatively the effects of human factors improvements on aircraft readiness.

AMES does not attempt to model all of the stimuli that might affect a real aircraft squadron, such as hostile enemy activity or fuel shortages. However, some of the peculiarities of a carrier based squadron are built into AMES. Modifications would be necessary to use AMES to model other similar systems, such as a ground based aircraft squadron. AMES has been designed to minimize the necessary modifications.

Aspects of the system that are outside the purpose of AMES are simplified. An aircraft mission, for example, is modeled by placing the aircraft in a particular set. Details of the mission other than times of takeoff or landing are ignored. This simplification is made because the details of a mission have no effect on the factors being studied by AMES.

ACRONYM: AMES

DESCRIPTION: (continued)

Those aspects that are directly related to the objectives of AMES are modeled in adequate detail to perform the desired analyses. Some of the more important segments include the aircraft, the components, human performance, planned maintenance, corrective maintenance, component failures, and errors.

AMES can be considered as three basic components and the interactions between them. The components are: a supply of aircraft, a schedule of missions, and a maintenance facility. There are three possible interactions between these three components. Two of these are manifest in the AMES Model: The interaction between missions and aircraft and the interaction between aircraft and maintenance.

The interaction between missions and aircraft is a simple one. Whenever a mission is scheduled and two operationally ready aircraft are available, the mission is flown. Whenever a mission is scheduled and two operationally ready aircraft are not available, the mission is deferred for a period (called the scrub time) or until operationally ready aircraft become available. If the mission is not flown before the end of the scrub time, the mission is cancelled (scrubbed).

The interaction between the aircraft and the maintenance facility involves planned (or preventive) maintenance and corrective maintenance. In one mode, the maintenance facility attempts to perform planned maintenance actions on aircraft which are not on flight duty. These actions are performed as much as possible in accordance with a planned maintenance schedule. In the other mode, the maintenance facility attempts to correct aircraft failures as they occur. Both modes of maintenance operate simultaneously and comprise the interaction between maintenance and aircraft.

The objective underlying the interaction between aircraft and missions is to fly as many of the scheduled missions as possible. The objective underlying the aircraft and maintenance interaction is to continually maintain the highest level of overall squadron operational readiness.

ACRONYM: AMES

DESCRIPTION: (continued)

Data input requirements are extensive. In addition to typical inputs such as aircraft type and number, each individual aircraft must have assigned to it certain attributes, such as total flight hours, flight hours or calendar days since a certain type of inspection was performed, etc. The user must supply a database which fits the structure of the system.

In addition, the AMES program expects another set of data which consists of parameters that control the operation of the program. These include such parameters as the duration of the run, the frequency of each report, etc.

The AMES program generates two kinds of output: reports and traces. Both forms are controlled by user input.

A report consists of certain information which describes a particular aspect of the current condition of the simulated squadron. The "Status Report", for example, indicates the status of each aircraft at the time of the report. The frequency of each report must be specified by the user.

Traces were originally built into the AMES program as a debugging tool. They can still be used for debugging in case of future developmental work. Also, traces can be used to follow the execution of the program in greater detail. Peculiarities and uncertainties can be more closely examined by "tracing" that part of the run in which they occur. Traces are turned on or off by user input.

AMES was developed in 1980 by XYZYX Information Corporation.

CATEGORY:

4

ACRONYM:

AMSEC

NAME:

Analytical Methodology for System Evaluation and Control

PURPOSE:

To support management planning for major programs.

ENTRY No(s):

4-12

MODEL DATA:

Fortran; IBM 360

DESCRIPTION:

AMSEC uses as figures of merit for a system its reliability, maintainability, availability and life-cycle support cost (RMAC). By choosing appropriate definitions for these terms, the methodology can be applied to total systems or to components, to a lifetime profile of plans for use, or to a single specified mission, to overall effectiveness in meeting design goals, or to performance at different specified levels of tolerable degradation.

Input Data describes, to the level of accuracy possible at a given point in the development, the design configuration, the life characteristics and cost of the components making up the system; the maintenance and logistics support parameters; the mission profile and plan for use.

From such inputs, AMSEC can be used to generate estimates of RMAC based on particular combination(s) of parameter values; to break these estimates down by system, subsystem, or component as desired, or by failure category and/or changeability criteria; to examine the effect on RMAC of alternative changes in the way the system is designed, supported, and used, and to selectively identify that combination of changes which forecast the most improvement in system effectiveness and/or in cost reduction.

The model was developed in 1976.

CATEGORY: 4

ACRONYM: ARMS

NAME: Aircraft Reliability and Maintainability Simulation

PURPOSE: To perform operational, reliability and maintainability analysis studies of aircraft systems.

ENTRY No(s): 4-08

MODEL DATA: GPSS and Fortran; 30 minutes run time; IBM 360/65.

DESCRIPTION: The ARMS model is a flexible analysis tool which can be applied to a wide range of simulation experiments without the need for reprogramming.

The model is augmented by a series of input programs which perform extensive data checking and provide diagnostics to aid the user in preparing data for the model.

An output program is also provided to allow the user control over the output data selection and formatting process.

The entire series of programs is designed to be used without any knowledge of the programming language involved.

The ARMS model can be used for predictions of maintenance and logistics support requirements for conceptual aircraft, studies of the impact of proposed changes to maintenance and/or logistics policies for current aircraft, and studies of the impact of proposed product improvements to existing aircraft.

Input data include: number of aircraft; flight endurance for up to four configurations; maximum number of deferred maintenance actions before unscheduled maintenance; definition of the components of the aircraft, including failure rate, flight or mission essentiality, probability of a failure of the component causing an abort, probability that a failure of the component will be discovered at the time of failure, mean time to repair, personnel required to perform repair, ground support equipment needed for repair, mean time to remove and replace, personnel and GSE required to remove and replace, percentage of

ACRONYM: ARMS

DESCRIPTION: (continued)

repair actions that are remove and replace versus repair in place, and probability of a test flight being required following repair; maintenance personnel available on each work shift (up to 3 shifts) at each maintenance level (up to 4 levels) identified by job description; mission scenarios defined in segments (up to 90 segments); scheduled maintenance event definitions; mission launch schedules; consequences of an abort caused by a failure in flight and the probability of each consequence; and when discovered probabilities.

The ARMS model generates an extensive set of output data. Some of the important output parameters generated are operational availability, norm, NORS, personnel and equipment utilization, mission success, and spare parts consumption.

The model was developed in 1975.

CATEGORY: 4

ACRONYM: ASM

NAME: Aircraft Sustainability Model

PURPOSE: To develop and evaluate budgets for war reserve material.

ENTRY No(s): 4-92

MODEL DATA: Fortran; IBM PC

DESCRIPTION: ASM is a model of wartime sustainability that relates resources to fighting ability over a period of time. It relates funding by weapon system to the probability of attaining specified flying levels of the Air Force War and Mobilization Plan (WMP). It optimizes logistic spares support simultaneously for multiple days of the WMP scenario by combining two systems.

The Marginal Analysis System (MAS), is a multi-echelon, multi-indenture model that optimizes logistics spares support for a single day. Multiple MAS runs are used to analyze multiple days of the scenario. A Cross-linker is then used to access and combine the MAS output files and to simultaneously optimize spares support.

Input data includes: number of units deployed, number of deploying bases, means and variances for the underlying demand process, automatic pipeline "purchases," daily flying hours, pre-surge warning time, maximum number of NMCS aircraft that can be grounded for a day, base repair time, order and ship time, depot repair time, failures per flying hour, base not repairable this station rate, condemnation percentage, unit procurement cost, quantity per application, future application percentage, procurement lead time, and starting spares levels.

Output data consists of a curve of the probability of achieving a prescribed level of activity on a specific day of the war as a function of the war reserve materiel spares budget.

The model was developed in 1987. It enables military planners to develop and evaluate large scale budgets for war reserve material. ASM was derived from the Aircraft Availability Model (AAM).

CATEGORY:

4

ACRONYM:

ASSCM

NAME:

Avionics Software Support Cost Model

PURPOSE:

To estimate the software support costs of various functional types of avionics equipment during the conceptual program phase.

ENTRY No(s):

4-16

MODEL DATA:

Fortran

DESCRIPTION:

ASSCM is a predictive model for systems whose expected life is between the year 1970 and 2025. The model may be used to project costs for the a variety of systems, including navigation and weapon delivery, electronic countermeasures and jamming, fire control, and command and control.

The model was derived in 1982 from data secured from Air Logistics Centers and thus is based on Air Force experience.

CATEGORY:

4

ACRONYM:

BRAT

NAME:

Budget Readiness Analysis Technique

PURPOSE:

To provide early insight into the type of information which LCOM can generate only after detailed networks have been developed and detailed input data have been prepared.

ENTRY No(s):

4-20

MODEL DATA:

2,500 Fortran statements; 10 minute run time;
Honeywell 635

DESCRIPTION:

The budget/readiness analysis technique (BRAT) model was developed as a tool for examining the relationship between the support system resources and weapon system readiness. It examines the effect of varying levels of spares, manpower, and support equipment upon the number of aircraft sorties that can be flown.

BRAT models the operations, maintenance, and supply functions of a single base. Both the base level and flight-line level of maintenance are modeled.

BRAT is intended to be a simple, fast model with minimum data requirements. It is useful in the early stages of weapon system acquisition, where little data is available and where the analyst is not working at a very detailed level.

Inputs include data concerning model elements: system (18), resources (21), maintenance (12), surge (6), control (6), line replaceable units (10), manpower (6), and support equipment (6).

Output data are summary and periodic reports of sorties and resource requirements.

The model was developed in 1983.

CATEGORY: 4

ACRONYM: CORE

NAME: Cost Oriented Resource Estimating

PURPOSE: To estimate operational and support costs.

ENTRY No(s): 4-26

MODEL DATA: Fortran

DESCRIPTION: CORE develops a measure of the annual resources required to operate and support the basic quantity of a weapon system which constitutes an operational unit.

It sums the annual costs in eight major resource categories, including unit personnel, unit level consumption, depot maintenance, sustaining investment, installation support personnel, indirect personnel support, depot non-maintenance, and personnel acquisition and training. Each resource cost is itself a sum of lower level computations, in a hierarchical structure.

The model was developed in 1981 under guidelines contained in the "Aircraft Operating and Support Cost Development Guide," published by the DOD Cost Analysis Improvement Group (CAIG).

An interactive computer revision of the CORE model was developed by HQ USAF. It is currently used for weapon system comparisons, programming exercises, Independent Cost Analyses (ICAs), and Operation and Support (O&S) baselines.

CATEGORY:

4

ACRONYM:

DYNA-METRIC

NAME:

DYNAmic Multi-Echelon Technique for Recoverable
Item Control

PURPOSE:

To determine spares constrained combat capability.

ENTRY No(s):

4-31 through 4-37, 4-70

MODEL DATA:

15,000 Fortran statements; Honeywell 6000 and
Sperry 1100/60 computers.

DESCRIPTION:

DYNA-METRIC is an analytic model that forecasts how
logistics support processes affect capability in a
dynamic wartime environment.

It forecasts the quantity of each aircraft
component in repair and resupply throughout a
wartime scenario, based on the component's unique
interactions with the developing operational
demands.

It also combines these quantities probabilistically
to estimate how all the aircraft components jointly
might affect aircraft availability and combat
sorties throughout the scenario.

Because the model is analytic, it can (optionally)
identify those problem parts that most limit
aircraft availability, or it can suggest a cost
effective stock purchase to improve aircraft
availability.

DYNA-METRIC portrays component support processes as
a network of pipelines through which aircraft
components flow as they are repaired or replaced
throughout a single theater. Each pipeline segment
is characterized by a delay time that arriving
components must spend before exiting the segment.

The expected number of components in each pipeline
segment depends on the rate at which demands occur
and the time components spend in each segment. The
model expands each component's expected pipeline
size into a complete probability distribution for
the number of components currently on order and in
repair, so the probability distributions for all
components can be combined to estimate aircraft
availability and sorties.

ACRONYM: DYNA-METRIC

DESCRIPTION: (continued)

When computing spares requirements, the program adds spare assets that will probably increase the number of available aircraft at minimal cost. When identifying problem parts, the model sequentially selects components based on the extent to which they will probably limit fully mission-capable (FMC) aircraft.

DYNA-METRIC has several limitations:

1. Repair procedures and productivity are unconstrained and stationary except when repair capacities are explicitly stated.
2. Forecast sortie rates do not directly reflect flight line resources or the daily employment plan.
3. Component failure rates vary only with flying intensity.
4. Aircraft within each base are assumed to be nearly interchangeable.
5. Repair decisions and actions occur only when testing is complete.
6. Component failure rates are not adjusted to reflect previous FMC sorties accomplished.
7. All echelons' component repair processes are identical.
8. Some capabilities were excluded from the model because they fell outside the realm of component repair. Others were excluded because the relevant problems have not been solved mathematically.

The model provides operational performance measures that show how local resources and productivity combine to affect overall weapon system support.

The model incorporates dynamics for evaluating echelon and function interaction in a wartime environment, when external demands increase and the logistics system reorganizes to meet those demands.

ACRONYM: DYNA-METRIC

DESCRIPTION: (continued)

The model forecasts how increased component demands would interact with available repair resources and priority repair. Thus, the adequacy of available repair capability to achieve the desired operational wartime capability can be assessed.

The model identifies and ranks problem components and support processes that cause excessive degradations to wartime capability.

Finally, the model can either assess existing resources and productivity or it can suggest a cost-effective mix of component spares to achieve a target wartime capability.

The model was developed in 1980 and has been revised several times. A condensed version of the model (MINI-DYNA-METRIC) has been developed for use on micro-computers such as the Z-100.

CATEGORY: 4

ACRONYM: GOALS

NAME: General Operations And Logistics Simulation

PURPOSE: To evaluate operational plans, logistics concepts, and resource levels.

ENTRY No(s): 4-43

MODEL DATA: GPSS and Fortran; 35 minutes run time; IBM 360/65

DESCRIPTION: The model is designed to evaluate and measure the impacts of various operational plans, logistics concepts, and resource levels (spares, people, etc.) as they apply to operating and supporting a specified number of military aircraft over a desired time span. All these elements or any one, such as resource levels, can be altered to determine the effects on operational effectiveness or life cycle costs.

A cost model is an integral part of the overall simulation model, which takes the simulation output and transposes it into dollar values. Life cycle costs are identified by several elements to provide a clear portrayal of the cost sensitive elements as variations are introduced into the model.

CATEGORY: 4

ACRONYM: ILSSM

NAME: Integrated Logistics Support Simulation Model

PURPOSE: To analyze the integration of logistics support with aircraft plan for use and preliminary design.

ENTRY No(s): 4-06

MODEL DATA: 2,000 GPSS V and Fortran statements; 5 minute run time; IBM 370/158-168.

DESCRIPTION: The model simulates aircraft flight operations and related support functions which correspond to particular maintenance and supply policies for a specific operating environment. It treats each aircraft as a group of sub-systems each of which has its own reliability and maintainability characteristics.

The model is capable of simulating the operation of an entire squadron of aircraft and will report consequent operating statistics. Statistical information on all phases of aircraft operations and requisite support systems is available. The information may be categorized as either squadron, aircraft or logistics support system related.

Input data includes: aircraft definition and operating characteristics; resource definitions and capacities; squadron operating scenario; aircraft inspection and system dependent probabilities; aircraft inventory information, inspection time lines, and maintenance time lines.

Output data includes: scheduled mission completion rate; squadron operational readiness probabilities; aircraft operational ready rate; average flight hours per month per aircraft; aircraft maintenance turnaround time; aircraft maintenance hours and maintenance man-hours per flight hour; aircraft flight hours per the time period on station; total sorties demanded, launched, and aborted; total aircraft lost and completing mission. Statistics are generated for each aircraft system/subsystem and resource groups (i.e. personnel/equipment).

The model was developed in 1977 by General Dynamics Corporation.

CATEGORY:

4

ACRONYM:

IREM

NAME:

Incorporation of Readiness into Effectiveness
Modeling

PURPOSE:

To compute the influence of parts stockage on
aircraft availability.

ENTRY No(s):

4-45

MODEL DATA:

Fortran; CDC 7600.

DESCRIPTION:

IREM is a Monte Carlo simulation that attempts to
compute the influence of parts stockage on aircraft
availability for approximately two companies of
helicopters.

During the simulation, aircraft perform missions in either a peacetime or wartime environment. When the aircraft are attacked in wartime the model determines the probability of the aircraft being hit by either fragments or projectiles.

Subsequently, the model determines whether the aircraft are lost or are repairable.

The model has preprocessors to reduce the extensive volume of projectile and fragmentation shotline data to support the simulation. The preprocessors consist of three programs.

The first program accomplishes the initial packing of projectile and fragmentation shotline data. This level of data reduction is sufficient for projectile shotlines due to the lesser number of projectile hits likely to occur during a mission.

The second program accomplishes additional packing of fragmentation shotline data which is required for fragmentation shotlines because there are 200 shotlines for a fragmentation hit.

A third program, the high explosive preprocessor, is responsible for packing the high explosive shotline data.

The model was developed in 1983.

CATEGORY: 4

ACRONYM: LCOM

NAME: Logistics Composite Model

PURPOSE: To simulate airbase logistics support operations.

ENTRY No(s): 4-51 through 4-60

MODEL DATA: Versions in Fortran and Simscript; operable on a variety of main-frame computers.

DESCRIPTION: LCOM is a composite of individual programs that communicate directly with each other to function as a unit.

The software is composed of four modules: Input, Main, Post Processor, and Restart.

The model measures sortie generation capability, maintenance manpower and supportability. It considers the interactions of all support resources (i.e., manpower, spares, support equipment, or facilities) and is useful for trade studies and sensitivities of aircraft logistics performance. It provides data on which to base comparisons of sortie generation capability of alternative weapon systems. It is also useful for manpower planning and tradeoffs concerning supportability.

Input Module. The primary function of the Input Module is twofold:

a. It translates (reduces and reformats) the data provided by users on easy to use input forms into a data structure that is suitable for use by the Main Module. This is called Initialization.

b. It generates sorties according to a user specified flying and activity program that will exercise the support system in the Main Module. The flying program is defined in terms of missions and/or activities requiring specific types and quantities of aircraft or non-aircraft resources.

The Input Module will edit input data and provide diagnostics when inconsistencies are found. In some cases where ambiguities exist, the model makes an assumption concerning user intentions. This feature avoids a program abort when the assumption is acceptable.

ACRONYM: LCOM

DESCRIPTION: (continued)

When an assumption cannot be made, the execution is terminated after all data has been edited. These edits are not exhaustive but cover a wide range of possible errors.

Main Module. The Main Module performs the actual simulation based upon the data provided. The logic of the software, together with the data logic, permits the simulation of a support response to the flying schedule.

Simulation includes generating weapon system malfunctions or parts failures corresponding to the reliability data, processing the tasks that must be done to correct failures, demanding the resources required to accomplish the tasks, and controlling the interactions resulting from resource shortages.

Resources are physical portions of the support system: aircraft, parts, equipment, men, or anything with a unit measure required to perform a task.

Most parts are deemed recoverable items. They are replaced according to a user specified, one for one inventory replacement policy. When a non-reparable failed part is sent to another repair facility, one serviceable like item is returned to stock after an order/shipping time delay. Consumable parts may be included without a batch replenishment policy.

Post Processor Module. This Module accomplishes a post-simulation analysis function.

A large amount of detailed data is generated during a simulation. The Main Module produces a Summary Report at discrete time intervals or at specified points in time.

The function of the Post Processor Module is to develop single products displaying selected summary statistics covering the entire simulation, consolidating the periodic reports produced during the simulation.

It also produces aircraft, manpower, mission, sortie, and part status information as a function of simulated time.

ACRONYM: LCOM

DESCRIPTION: (continued)

Restart Module Functions. This Module provides a data retrieval and restart capability that allows a run to be reinitiated at some point in the simulation, thus allowing alternative choices to be investigated at specified junctures. This feature is only applicable on the Honeywell 600/6000.

LCOM is a very complex model to run. Typical input consists of 8,000 to 10,000 lines of network code. Input contains data on failure rates, resources, tasks, aircraft operations, maintenance policies, mission types, priorities, cancellation policies, and tradeoff times.

Outputs include statistics on mission success, aircraft availability, manpower usage, supply, shop repair, support equipment and facilities.

The model was created in 1966 and has been modified numerous times.

CATEGORY: 4

ACRONYM: MACATAK

NAME: MAintenance Capability ATtAck

PURPOSE: To evaluate maintenance systems.

ENTRY No(s): 4-64

MODEL DATA: Fortran/GASP; 350 seconds run time; CDC 6000 series; Vax 11/780

DESCRIPTION: MACATAK is a discrete event, stochastic simulation model that was created from a group of simulation models called MAWLOGS (Models of the Army Worldwide Logistics System).

MACATAK was designed to analyze the operations of a multi-end item, multi-echelon maintenance system; measure the degradation of maintenance system performance and the impact of attacks of varying intensity and duration against the system produced by conventional, chemical, and nuclear weapons; and aid in evaluating attack strategies on the maintenance system. MACATAK is not restricted to any one particular maintenance system.

The model was developed as part of the Theater Nuclear Force/Survivability program.

Input data includes maintenance system resources (repair parts, components, life equipment, test, transport and "other" equipment and men); maintenance actions (resources needed for repair of each component, time to repair and frequency of occurrence); maintenance support structure (active nodes and diversion scheme around destroyed nodes); scenario (time phased demands and priority of units); fleets (size, priority and mean time between failure); and attacks (when, where, what and shot lines).

Output data consists of tabular and graphic printouts of probable equipment availability; tabular listing of equipment maintenance turnaround time (TAT); tabular listing of TAT broken into function segments; tabular and graphic printouts of queue sizes for parts, skills, and equipments as a function of time.

MACATAK was developed in 1980 by BDM.

CATEGORY: 4

ACRONYM: MBSGM

NAME: Multi-Base Sortie Generation Model

PURPOSE: To study factors that affect aircraft sortie generation.

ENTRY No(s): 4-78

MODEL DATA: Fortran; IBM 3081

DESCRIPTION: MBSGM is an analytical, Monte Carlo, discrete-event model. It simulates aircraft turnaround including maintenance, aircraft battle damage repair, and quick turn procedures based on input parameters such as subsystem reliability and maintainability, and repair resource levels.

Sortie capability is based on user inputs for tasking as well as repair and regeneration time distributions. User-scheduled external events, such as airfield attacks, may be added, as well as changes to original input parameters to simulate resource changes or varying time distributions.

Duration of play is 30 days, with no specific limit to iterations. The model will accommodate twenty bases, one set of repair characteristics for each aircraft type (air to air or air to ground), and maintenance for aircraft major subsystems.

Input consists of sortie tasking, battle damage and attrition rates, repair probabilities and time distributions, recover logic, and user scheduled events.

The output consists of computer printouts with time oriented statistical summaries.

The model was developed in 1985 by Air Force Studies and Analysis.

CATEGORY: 4

ACRONYM: METRIC

NAME: Multi-Echelon Technique for Recoverable Item Control

PURPOSE: To determine optimum stock levels.

ENTRY No(s): 4-80

MODEL DATA: 800 Fortran statements; 10 minute run time; IBM 360/65.

DESCRIPTION: METRIC is an analytical model designed to determine optimal stock levels of recoverable items in a system consisting of a depot and up to twenty bases.

The model considers trade offs between stock items in order to minimize expected back orders subject to budget constraints. It minimizes the sum of back orders on all recoverable items at all bases having the same weapon system subject to a given dollar investment in assets.

The input data deck consists of three parts:

1. Headings, parameters used in input and output, and variables used in the program calculations.
2. Item data cards for each stock item.
3. Codes that select a value or vector of values from the coded parameter table.

Output data consists of optimal stock levels.

METRIC was developed in 1968. Its limitations led to the creation of MOD-METRIC and DYNA-METRIC.

CATEGORY: 4

ACRONYM: MLCCM

NAME: Modular Life Cycle Cost Model

PURPOSE: To trade life cycle costs, at the subsystem level, during conceptual and preliminary stages of a new aircraft development program.

ENTRY No(s): 4-77

MODEL DATA: 11,500 Fortran statements; CYBER-750.

DESCRIPTION: MLCCM provides a design-based, computerized methodology for predicting advanced technology aircraft costs to major subsystem levels for the RDT&E, production, initial support, and operations and support phases of the system life cycle during conceptual and preliminary design.

The methodology consists of a set of life cycle cost estimating relationships which form the master control program and are used as an engineering/cost tool to facilitate the conduct of cost related engineering design analyses.

The computation begins with the selection of the type of aircraft (fighter/attack/bomber or cargo/transport/tanker) to be analyzed. After the appropriate design parameters are defined, the user selects an interactive or batch operating mode.

The MLCCM program offers the user a matrix of life cycle costs for various aircraft subsystems.

Other inputs include: aircraft designation and life cycle, dollar year, inflation factor, general and administration percent, selected subsystem, selected phase (RDT&E, production, support investment, operations and support).

Output data includes: one life-cycle cost phase for one or all subsystems, and all life cycle cost phases for one or all subsystems; calculation of year dollars to any desired constant year dollars, and the costs by life cycle phase and aircraft subsystem; cost elements distributed by subsystem, with totals for distributed cost elements by subsystem.

The model was developed in 1985.

CATEGORY: 4

ACRONYM: MOD-METRIC

NAME: MODified Multi-Echelon Techniques for Recoverable Item Control.

PURPOSE: To provide a method for control of a multi-item, multi-echelon, multi-indenture system for recoverable (secondary) items.

ENTRY No(s): 4-83

MODEL DATA: 875 Fortran statements; Honeywell 635

DESCRIPTION: The model is limited to two-echelon multi-item systems in which an item may be demanded at any one of several locations called bases; in turn, these bases receive inventory from a central location called a depot.

The objectives of the model are to describe the logistics relationship between an assembly (LRU) and its subassemblies(SRU), and to compute spare stock levels for both echelons for the assembly and subassemblies with explicit consideration of this logistics relationship.

In particular, the model is used to determine base and depot spare stock levels which minimize total expected base backorders for the assembly subject to a system investment constraint. The model can also be used to study the effect on investment requirements of varying pipeline lengths (repair times, transport times).

Input data include: average base and depot repair times, unit costs, average order and ship times, not-reparable-this-station (NRTS) rates, and probability distribution parameters. A starting budget is estimated as a function of pipeline quantities.

The output consists of depot and base stock levels for each of several (up to 20) budget levels. In addition, condemnation quantities, fill rates by base, system backorder days/day, and probability estimates of having zero through nine backorders at each base are displayed.

The model was developed in 1973 as an extension of Rand's METRIC model.

CATEGORY: 4

ACRONYM: MOVES

NAME: Marine Operational V/STOL Environment Simulation

PURPOSE: To simulate flight, maintenance and supply activities of the USMC AV-8A, B and C Harrier squadrons and detachments in wartime and peacetime, on land or at sea.

ENTRY No(s): 4-68

MODEL DATA: GPSS language; IBM 3033

DESCRIPTION: The MOVES system is composed of two compatible models, the Organizational Maintenance Activity (OMA) model and the Intermediate Maintenance activity (IMA) model. These two models are joined together by a supply sub-model.

The OMA model simulates the movement of aircraft and maintenance actions through OMA, while the IMA model simulates the passage through the IMA (to supply) of items removed at OMA. The models can be exercised independently or interactively.

Input to the moves system consists largely of data extracted from automated sources such as the maintenance and material management (3-M) system complemented by non-automated sources.

The output forecasts the effects that changes in factors such as mission schedules, manpower allocations, maintenance and supply policies, spares and support equipment and aircraft modifications have on measures including mission capability, aircraft availability, spares protection level, sorties achieved, and direct maintenance man-hours per flight hour.

The model was developed in 1983 and is currently used to evaluate alternatives for employment of AV-8 squadrons.

CATEGORY: 4

ACRONYM: NAVMAN

NAME: NAVMAN

PURPOSE: To estimate maintenance personnel requirements for Navy aircraft.

ENTRY No(s): 4-85

MODEL DATA: PL/I

DESCRIPTION: NAVMAN is a deterministic computer model which replicates the methods currently used in Navy personnel planning for aircraft in fleet service.

Maintenance support of Navy aircraft is performed at three levels -- organizational, intermediate, and depot.

NAVMAN estimates organizational and intermediate maintenance personnel requirements, both preventive and corrective, for new aircraft systems.

Also, the model permits analysis of personnel requirements consequences caused by changes in the flying program, reliability and maintainability, and other flying activities.

Inputs include: operations information for both sea and shore environments (sortie rate, sortie length, and flying days per week); organizational features (squadron size, number of squadrons, aircraft type, and number of work shifts); and maintenance characteristics (maintenance manhours per flying hour, or per sortie, or mean time between failure and mean time to repair).

Model outputs are reported in various formats: ship requirements and shore requirements, for each organization level, for the total fleet, individual squadrons, and work centers.

The model was developed in 1979.

CATEGORY: 4

ACRONYM: PARCOM

NAME: PArts Requirements and COst Model

PURPOSE: To provide gross estimates of wartime spare parts requirements and costs as they relate to flying hour and availability objectives.

ENTRY No(s): 4-88 through 4-90

MODEL DATA: Fortran; Sperry 1100/82.

DESCRIPTION: PARCOM is an expected value simulation of the spare parts requirements generation process for cases defined by combination of parameters.

The model computes the capability potential of the force when operated with each computed spares mix. The assessed capability potential is in terms of achievable aircraft availability and fraction of flying hour program which can be accomplished.

The initial PARCOM methodology was later expanded to include a partial-substitution parts replacement policy and distribution of stock over time.

As with basic PARCOM, extended PARCOM relates aviation spare parts requirements and fleet capability to flying hour and availability objectives, part replacement (substitution) policies, and stockage deployment schedule, all subject to optional cost constraints.

Input data include data for each type of part (includes cost, failure rate, order-ship time, repair time and on-hand) and scenario data (scenario specific data, scenario constraints, additional parts data, replacement policy, and inventory capabilities).

Output data consist of total cost data and availability data.

The program was developed in 1984 and 1985.

CATEGORY: 4

ACRONYM: PLANET

NAME: Planned Logistics ANalysis and Evaluation Technique

PURPOSE: To examine the hardware configuration, operations and logistics support interactions of a variety of weapon systems in a single or multi-base setting.

ENTRY No(s): 4-91

MODEL DATA: Simscript I.5 and Fortran IV languages; size and run time varies with each model; IBM 360/65

DESCRIPTION: The PLANET system contains four simulators and a report and analysis library. The simulators can be used separately to examine specific areas of the logistic system, and conjointly to simulate the complete weapon system operation from the site or point of demand through to the depot.

The Availability and Base Cadre Simulator (PLANET-ABC) is intended to simulate the organizational maintenance activities on the base(s).

The structure of the model allows study of a broad range of scenarios. Sorties may be flown from one or more bases over some period of time, with associated flight generated failures; pre-flight, post-flight, and periodic maintenance actions; personnel, spare parts, and maintenance equipment demands; queues, probabilistic delays; variable personnel staffing by type, base and shift; travel times with delays and equipment failures; part failure modes and failure levels; maintenance repair time distributions; etc.

The ABC simulator can be used to examine the impact of changes in hardware design and/or operational requirements on an existing organizational support system and to develop the organizational support requirements for given or existing hardware designs and operational requirements.

It can also be joined to the Bench Repair (PLANET-BR) simulator, enabling the user to examine problems encompassing all the base functions.

ACRONYM: PLANET

DESCRIPTION: (continued)

The Depot Transportation (PLANET-DT) simulator simulates the movement of logistics resources (people, parts and equipment) from base to base and from base to depot or factory, and return. The transportation network may consists of as many different load and off-load points as desired.

The simulator takes as inputs the various operating characteristics of the transportation system, the expected cargo to be moved through time, and a planned set of transport vehicles. The vehicles can be any combination of trucks, airplanes, ships, or the like.

It then simulates the operation of the system through time and records the data from which reports can be printed that reflect the performance of the transportation system under the conditions specified by the inputs.

Performance is measured in terms of the amount of different types of cargo moved.

The Depot Repair and Overhaul (PLANET-DRO) simulator simulates a spectrum of depot activities, including repair and overhaul processes.

The model was developed in 1968 by RAND.

CATEGORY: 4

ACRONYM: SAMSOM

NAME: Support Availability Multi-System Operations Model

PURPOSE: To simulate weapon system operations and logistics support events at one or more bases for selected periods of time.

ENTRY No(s): 4-96 and 4-97

MODEL DATA: 25,000 Simscript I.5 statements; up to 3 hours run time; IBM 360-370

DESCRIPTION: SAMSOM simulates the capability of an aircraft organization to generate sorties and turn aircraft to support peacetime flying/training programs, to meet maximum effort readiness requirements, and to provide close-support, air defense, and interdiction capabilities. The model simulates operations events associated with readiness postures and alert commitments or requirements.

The initial version of the model was developed by RAND in 1964. An improved version, SAMSOM II, was produced in 1967.

The four major kinds of inputs used in the model are operations events and policies, support resources, hardware characteristics, and maintenance management policies.

SAMSOM II inputs identify and define all variables in each simulation, including bases, aircraft types, operations policies, sortie requirements, resources, system reliability or break rates, repair times, inspection requirements, and ground abort rates.

SAMSOM outputs may be divided into two categories: (1) simulation inputs, model initialization parameters, computer memory maps, error diagnostics and simulation statistics, and (2) simulation results printed out on eleven different kinds of output formats.

Additional outputs are also available, providing details primarily used for simulation trouble shooting and debugging. All outputs are optional and, in some cases, the user may select specific data or statistics from within a set of outputs.

CATEGORY: 4

ACRONYM: SESAME

NAME: SElective Stockage for Availability, MultiEchelon

PURPOSE: To determine optimum stockage levels.

ENTRY No(s): 4-99

MODEL DATA: Simscript

DESCRIPTION: SESAME is a multi-item, multi-echelon model that determines by means of mathematical optimizing techniques how many of each component to stock at each type stockage point in the supply system, taking into account the potential impact of each backordered component on system down time.

Sesame will stock to achieve any given weapon system target availability at least cost.

For the most part, the model is a synthesis of already existing mathematical techniques incorporated into a package designed to maximize user convenience and compatibility with the Commodity Command Standard System.

Input data include: the amount of an item at an echelon 3 unit, number of stocking units at echelon 3, unit price of item, percent of time system is down due to unavailability of the component.

The SESAME model is used in both budget and production modes.

In budget mode, it develops curves showing the relationship between target operational availability and necessary inventory investment.

In production mode it produces punch cards by which the stockage quantities it computes are entered into the provisioning master record.

CATEGORY: 4

ACRONYM: SIMLOG

NAME: SIMulation of LOGistics

PURPOSE: To study the interactions between maintenance and operations events under a variety of operational configurations.

ENTRY No(s): 4-100

MODEL DATA: Simscript

DESCRIPTION: SIMLOG is a Monte-Carlo model that uses queueing to simulate operations and environment, including cyclic and stochastic activities of utilization, maintenance, supply.

Initial conditions are input to describe the tactical situation at time zero. The simulation is driven by the built in clock and the next event each system encounters in transitioning between states is predicted and entered chronologically into the computer memory storage for future program reference.

The objective of SIMLOG is to furnish a method for evaluating the complicated events inherent in the maintenance operations in a military environment.

The nature of the simulation is such that it can grow with the availability of real data. On its basic form (without real data), it can be used to establish sensitivity of its parameters which can provide design goals, establish priority of action, and measure the accuracy and sufficiency required for data gathering programs.

Input data includes parameter constants for the exponential repair time distributions; time constants for takeoff frequencies, mission lengths and the probabilities of passing inspections, system failures, parts and equipment availability, and repair.

Output data can be presented in both tabular and graphical format. The graphs plot time histories and system availability for one or a combination of input parameters.

SIMLOG was developed in 1973.

Jordan and Associates

AF88-092 Phase I

MODELS AND TOPICS OF GENERAL INTEREST

Name

ACABUG - American British Canada Australian Urban Game

Computer Simulation of Aircrew Management Policies

ERIC: An Object Oriented Simulation Language

Fleet Forecasting Model (or Simulation of Removals for Components
and Engines)

Hierarchical Planner

High Reliability Fighter Concept Investigation

An Interactive Computer Package for Use with Simulation Models
which Performs Multi-Dimensional Sensitivity Analysis by
Employing the Techniques of Response Surface Methodology

A Methodology for Evaluating Intra-Theater Airlift Operations and
the Bed-Down Decision

A Methodology for Operational Performance Evaluation of an
Aircraft in a Tactical Environment

The RAND-ABEL Programming Language: History, Rational, and Design

Strategic Airlift: U.S. to Europe

TAC SELECTOR

A User Definable SLAM Airfield Model Designed for Experimentation
and Analysis

V/STOL Concepts and Developed Aircraft

Wind Factor Simulation Model

CATEGORY: 5

NAME: ACABUG - American British Canada Australian Urban Game

ENTRY No(s): 5-07

DESCRIPTION: The four ABCA nations (America, Britain, Canada, Australia) have jointly developed a computer assisted MOUT (Military Operations in Urban Terrain) wargame named ACABUG (American Canadian Australian British Urban Game).

The model was designed as a MOUT model capable of representing a reinforced infantry company against an appropriate threat force. However, it has of necessity sufficient generality that it can handle a reinforced infantry company or armored battalion in either a rural or an urban setting. This report describes in general terms the structure and features of the ACABUG software.

ACABUG is a two sided, stochastic, high resolution, computer assisted, urban terrain wargame using three dimensional terrain boards on a 1:500 scale. Computer resolution is to the individual rooms for each represented building. Players move and deploy 1:500 scale miniatures on the terrain board to establish line of sight, detection, and engagement opportunities.

Engagements are initiated by means of input orders to the computer, which models direct fire, indirect fire, movement, mount and dismount, communications, target acquisition, and building clearance. Other functions such as minefields and obscurations are played through manual rules.

The game time to real time ratio is approximately 1:120 minutes. The model will allow 6,000 maneuver platforms and 4,000 buildings (80 types).

Input data consists of terrain, system performance, and force organization.

The primary output is a graphics display providing information and prompting player responses. A post processor provides a killer/victim scoreboard.

The model is programmed in Pascal and is coded for the PERQ microcomputer.

CATEGORY: 5

NAME: Computer Simulation of Aircrew Management Policies

ENTRY No(s): 5-14

DESCRIPTION: This model is designed to simulate the operational attributes of the jet transport aircraft and air crew of a Military Airlift Command (MAC) squadron.

Given resources, workload, and operating rules, the program schedules missions, selects the crews and planes, and flies the missions, with random fluctuations for delays and weather variations.

The program tracks system performance by acquiring operational data such as cancellations, flying time on each leg, and delays. Thus, the program permits observing the impact of various management policies on total system performance.

The simulation program focuses on 'people measures' as well as system measures. Its outputs have been validated twice against operational data of the total MAC C-141 force and have been found to be consistent with total operations.

The program yields data on system-wide operations in formats which facilitate management decisions on manning, crew welfare, tolerable workload, and mission effectiveness. Management can study the relationship among ground times, route structures, and maximum achievable surge rates. This crew oriented technique allows management to study simple and radical departures from existing aircrew management policies.

The information to be supplied to the simulation prior to a run can be grouped into five general categories: policy, route system characteristics, resources, workload, and predestined events.

CATEGORY: 5

NAME: ERIC: An Object Oriented Simulation Language

ENTRY No(s): 5-18

DESCRIPTION: ERIC is an object oriented programming language designed to support the development of intelligent, discrete, event driven simulations. It was created as part of an on-going research effort at the Rome Air Development Center to build a new generation of knowledge based simulations that support battle management studies.

Object oriented programming languages are designed to support the development and maintenance of large and complex software systems that are composed of objects which have certain attributes or behaviors. Objects communicate by message passing. The object oriented paradigm is useful in this case because many real world systems are composed of objects whose interactions can be represented by messages.

This report is a description of the ERIC language. It does not assume the reader is familiar with object oriented programming or simulation; however, it does assume that the reader is familiar with the LISP language.

CATEGORY: 5

NAME: Fleet Forecasting Model (or Simulation of Removals
for Components and Engines)

ENTRY No(s): 5-19

DESCRIPTION: The Fleet Forecasting Model (FFM) forecasts engine and module removals from a fleet of aircraft for designated time periods, such as calendar quarters. Removals are a function of the fleet size, the engine flying hours program, delivery schedules, maximum operating times of individual modules and parts, and opportunistic screening intervals. Screening involves removing parts close to their respective MOT's when the engine is already being removed for some other reason.

The model generates a significant amount of engine operation data. Some, such as engine and module removal status data, is printed out and written to other files. The majority of data, however, is shown in output display tables. This data includes engine and module removal rates, parts removals, and removals by cause.

The model has three purposes: to generate removal rate factors; to generate removal data for input to other logistics models; and to help plan repair schedules and estimates maintenance costs.

The FFM can be used to derive input factors for other models, such as MOD-METRIC and the Jet Engine Management Simulator. The model can be applied to any modular engine having internal life limited parts, such as the F100 and TF34.

CATEGORY: 5

NAME: Hierarchical Planner

ENTRY No(s): 5-22

DESCRIPTION: This thesis examines the use of an artificial intelligence technique, hierarchical planning, to solve the problem of generating an aircraft route and finding a path through hostile environments.

An algorithm using hierarchical planning is presented and tested against several hostile environments. The algorithm divides the problem space or grid, into smaller spaces or boxes. These boxes are then assigned values based upon the input hostile environment. Block paths are constructed and evaluated based on the values in the boxes. A search is performed on the two best block paths to find a flight path for the aircraft.

The program has 1,220 lines of PASCAL programming and was written for a VAX 11/750 and VAX 11/780 computer.

CATEGORY: 5

NAME: High Reliability Fighter Concept Investigation

ENTRY No(s): 5-23

DESCRIPTION: The objective of this study effort was to develop viable configurations for future fighter aircraft with high system reliability and supportability as the primary requirements. The specific goal was to develop fighter configurations which can operate within the constraints of projected deployment and autonomy requirements for 250 flight hours (30 days of sorties) with little or no maintenance.

Promising technologies were to be identified and analyzed to determine their impact on maintenance design characteristics that would effect the readiness and supportability of such an aircraft. Plans for the promising technologies were to be developed and integrated into a schedule which would permit acquisition of high reliability and minimum maintenance fighter in the 2000 time frame.

CATEGORY: 5

NAME: An Interactive Computer Package for Use with Simulation Models which Performs Multi-Dimensional Sensitivity Analysis by Employing the Techniques of Response Surface Methodology.

ENTRY No(s): 5-25

DESCRIPTION: The overall objective of this research effort was to develop an interactive, user-friendly response surface methodology computer package which can be attached to any Fortran based simulation model to yield a response function which describes the relationships between the input parameters and the output parameter of interest.

Specific objectives were:

- (1) after the response surface is generated, search the surface for the combinations of pertinent input parameters that yield the optimum response
- (2) interpret how the response function reveals the sensitivity of the output parameter due to changes in input parameters
- (3) illustrate how the response function describes the relative ranking of effects on response between input parameters.

The effort accomplished the overall objective and touched on objectives (2) and (3). The overall objective was accomplished by developing the RSM computer program. The user friendly requirement meant the program had to be flexible and easy to understand. The input requirements were designed to be easily understood and proceed in a logical sequence. Five design types are offered by this program and also a user design input subroutine offers further flexibility.

CATEGORY: 5

NAME: A Methodology for Evaluating Intra-Theater Airlift Operations and the Bed-Down Decision

ENTRY No(s): 5-30

DESCRIPTION: This thesis develops a method to assist decision makers in basing intra-theater airlift forces, aircraft and aircrews to best meet airlift job requirements. The strengths of optimization models and simulation models are used in the Bed-Down decision (location of the airlift forces in the network).

An integer linear programming model is developed to generate alternate candidate basing decisions for analysis and testing. A network simulation model, FLEETLIFT, is developed to evaluate the candidate basing decisions. This model captures the dynamic effects of the availability of material handling equipment, limited airfield ramp space, variable distances between network airfield locations, and variable combat attrition and planning factors such as limited aircrew work day and limited aircraft loading capacity.

CATEGORY: 5

NAME: A Methodology for Operational Performance
Evaluation of an Aircraft in a Tactical Environment

ENTRY No(s): 5-31

DESCRIPTION: This report presents a methodology for evaluating the operational performance of an aircraft in both hostile (wartime) and non-hostile (peacetime) environments. The methodology is applied to an investigation of the effect of self-repairing flight control system architectures on the system effectiveness, reliability, and maintainability of fighter aircraft. A two stage procedure for evaluating operational performance is described.

CATEGORY: 5

NAME: The RAND-ABEL Programming Language: History,
Rationale, and Design

ENTRY No(s): 5-35

DESCRIPTION: This report describes the motivations behind the development of the RAND-ABEL programming language and some of its novel features. RAND-ABEL was designed to meet the needs of the Rand Strategy Assessment Center, which is building a large system for automated war gaming in which separate rule based models represent U.S., Soviet, and third country behavior.

To satisfy speed and transparency requirements, the language was designed to be:

- (1) rapidly compilable and executable
- (2) self-documenting
- (3) understandable by nonprogrammer domain experts after modest instruction
- (4) reasonably easy to learn and use, especially for modifying or incrementally extending existing code
- (5) portable across different computers
- (6) well suited to development of large and complex rule-based simulations.

Certain of its features are unique: the ability to express directly in RAND-ABEL source code such natural structures as decision tables (isomorphic with decision trees) and order tables, which lay out orders to be executed sequentially; and its novel declaration-by-example feature, which is useful for rule based programs with enumerated variables and many distinct data types. RAND-ABEL has built in support for a data dictionary for communication between separate modules.

CATEGORY: 5

NAME: Strategic Airlift: U. S. to Europe

ENTRY No(s): 5-38

DESCRIPTION: This thesis studies the problem of determining wartime military airlift capability and factors within the military airlift system which produce significant changes in system capability as measured in tons of cargo delivered after 30 days of system operation.

The airlift mission is set in a scenario which requires the reinforcement of western Europe against a Warsaw Pact attack. This reinforcement is provided by C-141 and C-5 aircraft.

To examine the performance of the airlift system, a simulation model was created using SLAM (Simulation Language Alternative Methodology). This model encompasses the four major subsystems within the airlift system which are aircrew, maintenance, supply, and aerial port. These subsystems employ resources which are pooled at two locations (one in the U. S. and one in Europe).

CATEGORY: 5

NAME: TAC SELECTOR

ENTRY No(s): 5-39

DESCRIPTION: The TAC SELECTOR computer program is one of several computer programs used by the Saber Mix study group (AF/SAGF) to derive alternative stockpiles of non-nuclear air-to-ground ordnance for USAF tactical fighter/attack forces in a specified theater.

In general, the program selects the preferred delivery condition/weapon combination for each aircraft/target/weather state combination defined in the problem.

The model processes aircraft consecutively. Thus, there may be as many aircraft in the problem as the user defines.

The program was developed as part of the study entitled: 'An Improved Methodology for Determining Alternative Stockpiles of Air-to-Ground Munitions, and an Application of the Methodology to United States Air Forces in Europe' (U), dated 1 May 1971. The model is used to assist in defining the yearly buy of air-ground munitions for the Air Force.

The model was written for a Honeywell G-635 computer and consists of 800 lines of FORTRAN code.

Input data include: the names of target and weapon types, delivery condition and weapon combinations, aircraft types; payloads; expected kills and losses per sortie; desired target damage level; and cost data.

Output data consists of tables comparing weapon effectiveness on the basis of cost and sorties required per target kill and tables of preferred delivery conditions and weapons based on cost and sorties per kill.

CATEGORY: 5

NAME: A User Definable SLAM Airfield Model Designed for Experimentation and Analysis

ENTRY No(s): 5-40

DESCRIPTION: This research effort was undertaken to investigate a methodology for determining the most critical elements on a fighter-bomber airbase with respect to sorties generated over a three day period. The methodology is founded on a user definable computer simulation model written in SLAM (Fortran based) and supported by several Fortran routines.

The remainder of the methodology concerns factorial experimental designs for examining airfield element criticality. The various airfield elements are the experimental factors. They are set to specified levels according to the experimental design.

The principal model output is sorties generated over a three day period. Results are analyzed with common statistical techniques (Method of Contrasts, ANOVA, Duncan's Multiple Range Test).

Model usage is demonstrated with two experiments and their analysis. Because this methodology does not require Monte Carlo simulation of damage to the airfield, the determination of element criticality is straightforward. The lucrative targets on the airfield are then the most critical elements which can be effectively attacked with available weapons and delivery systems.

CATEGORY: 5

NAME: V/STOL Concepts and Developed Aircraft

ENTRY No(s): 5-42

DESCRIPTION: A comprehensive, in-depth review of the development of VTOL and V/STOL concepts and aircraft other than the helicopter is presented. The time period is from the beginning of government sponsored activity in the late 1940's through the present.

Included are V/STOL aircraft that use rotors but are designed to provide aerodynamic efficiencies and cruise speeds similar to those of conventional airplanes.

Although not aircraft in the conventional sense, wingless VTOL vehicles which use direct thrust (rocket or turbojet/turbofan) for lift in all flight modes also are included since such machines do have a close relationship to some of the more commonly accepted forms of VTOL aircraft.

Also included is an introductory review of V/STOL aircraft concepts and the rationale behind them. The concepts are categorized by propulsion system. The report contains definitive information and technical reviews of the rocket belt, turbojet or turbofan platform type (wingless) vehicles, and turbojet or turbofan vertical attitude takeoff and landing aircraft.

CATEGORY: 5

NAME: Wind Factor Simulation Model

ENTRY No(s): 5-43

DESCRIPTION: The Wind Factor Simulation Model is designed to reside as a collection of subroutines within the user's larger simulation model.

WFSM produces mean overall climatological wind factors for great circle routes between arbitrary points "A" and "B" (specified by latitude and longitude) anywhere on the globe. It produces wind factors in any of three modes (the calm wind case, 90-percent worst case, and the mean wind case), for either of two altitudes (25,000 ft. and 35,000 ft.) for any of four seasons of the year. In addition, the model can provide great circle distance between points "A" and "B". From this information and known airspeed, the user can calculate ground speed and adjusted flying time between "A" and "B". Software solves the equation of a great circle.

Input to the model includes global (latitude and longitude) coordinates of point "A" (takeoff) and point "B" (landing), the Julian base date of the wind factor request (used to determine season of the year), aircraft altitude, wind option, and airspeed. To accommodate future growth, the user must also stipulate Greenwich mean base time of the wind factor request and forecast hours ahead of the wind factor requested.

The model was written for the Honeywell 6000 series computers using Fortran.

Jordan and Associates

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COMPARISONS AND BIBLIOGRAPHIES

Name

Aircraft Survivability Model Repository

Air Ground Engagement Models Review

Analysis of Three AVCAL Inventory Models Using the Tiger Simulation Model

Appraisal of Models Used in Life Cycle Cost Estimation for USAF Aircraft Systems

Bibliography for Aircraft Parameter Estimation

Catalog of Wargaming and Military Simulation Models, 10th Edition

Combined Logistics Model: Concept and Identification Phase

A Comparison of Analytic and Simulation Reliability and Maintainability (R/M) Prediction Methods

A Comparison of Capability Assessment using the LOGRAM and DYNA-METRIC Computer Models

Compendium of Operations Research and Economic Analysis Studies

Computer Models Used by the Assistant Chief of Staff Studies and Analysis, Headquarters United States Air Force

Mathematical and Statistical Software Index

Selected Models and Techniques Compiled by HQ AFSC/ALT

Study of Unclassified DOD Owned or Public Domain Computer Games and Simulations and Their Applicability to the ACSC Associate Programs Seminar Curriculum

Survey of Models/Simulation at RADC

Theater Simulation of Airbase Resources and Logistics Composite Models: A Comparison

A Trade-off Study of TILT Rotor Aircraft versus Helicopters using VASCOMP II and HESCOMP

TSAR/DYNA-METRIC Comparison

Two Models for Optimal Allocation of Aircraft Sorties

CATEGORY: 6

NAME: Aircraft Survivability Model Repository

ENTRY No(s): 6-01

DESCRIPTION: The Aircraft Survivability Model Repository (ASMR) was established with the objective of providing a central location which would control store and disseminate selected survivability/vulnerability (S/V) models, to develop standardized data sets for baselining these models and for validation of models not under configuration control, and to establish a central point of contact for S/V model users to facilitate information exchange and problem resolution while reducing duplication of effort.

This report contains a summary of the activity of the model repository and the models provided as well as the integration of the model repository into the survivability/vulnerability information analysis center.

Among the models provided:

- (1) SAMS - Surface-to-Air Missile Simulation
- (2) P001 - Air Force Armament Laboratories Anti-Aircraft Artillery (AAA) simulation
- (3) PACAM V - Piloted Air Combat Analysis Model
- (4) PACAM 8
- (5) BLUEMAX II
- (6) SCAN - Aircraft Survivability Analysis Program.

CATEGORY: 6

NAME: Air Ground Engagement Models Review

ENTRY No(s): 6-02

DESCRIPTION: This technical review of Air-Ground Engagement Models was performed under the supervision of the Assistant Vice Chief of Staff of the Army to assist model users in determining the proper application of these models and the efficient allocation of available modeling resources.

The models reviewed were CARMONETTE V, EVADE II, and GLOBAL. The three models are two sided, have high resolution, and consider a variety of weapons. They also are frequently used in Army studies and updated and improved on occasion.

The CARMONETTE V Monte Carlo computer simulation was developed by the Research Analysis Corporation to evaluate combat engagements between forces of up to battalion size.

The EVADE II deterministic computer simulation was developed by the US Army Material Systems Analysis Agency to evaluate ground and air attrition as multiple aircraft fly missions over deployments of air defense weapons.

The GLOBAL Monte Carlo computer simulation was developed by the Stanford Research Institute to evaluate combat engagements of attacking air or ground units against defending ground units.

The review was accomplished by analysis teams from the US Army Management Systems Support Agency and the Models Coordinating Group from the Office of the Coordinator of Army Studies, Office of the Assistance Vice Chief of Staff of the Army.

CATEGORY: E

NAME: Analysis of Three AVCAL Inventory Models Using the Tiger Simulation Model

ENTRY No(s): 6-03

DESCRIPTION: This thesis investigates the effectiveness of three Aviation Consolidated Allowance List (AVCAL) inventory models in achieving aircraft system operational availability. The three models studied are the Aviation Supply Office (ASO) model, the Repairables Integrated Model for Aviation (RIMAIR), and the Availability Centered Inventory Model (ACIM).

TIGER, a simulation model developed by Naval Sea Systems Command, is amended to accommodate simulation of multiple aircraft sorties with a realistic parts pipeline operation. TIGER is the generic name for a family of computer programs which can be used to evaluate, by simulation, a complex system in order to estimate various reliability, readiness and availability measures.

TIGER is a flexible program that allows for sensitivity analysis by easy modification of part parameters and system configuration. Aircraft sorties are simulated over a period of ninety days and the resulting AVCAL model inventory levels are compared over a ninety day period utilizing availability statistics computed by TIGER.

CATEGORY: 6

NAME: Appraisal of Models Used in Life Cycle Cost Estimation for USAF Aircraft Systems

ENTRY No(s): 6-04

DESCRIPTION: The main objective of this report is to evaluate the most widely used life cycle cost models and other formal estimating methods applicable to aircraft systems.

The models included in the evaluation are:

- AFR 173-10 models:
 - Budgeting Annual Cost Estimating model (BACE)
 - Cost Analysis Cost Estimating model (CACE))
- Logistics Support Cost model (LSC)
- Logistics Composit Model (LCOM)
- MOD-METRIC
- AFM 26-3 manpower standards
- USAF Logistics Command Depot Maintenance Cost Equations
- Development and Production Costs of Aircraft (DAPCA) model
- Price Model (RCA model for avionics development and procurement costs)

The models are evaluated in a defined framework of life cycle cost elements and cost driving factors.

The report contains a discussion of the specific context and research approach taken in evaluating the individual cost models and defines the set of cost driving factors and life cycle cost elements used; an overview of each model's capabilities; and conclusions regarding the use of life cycle cost models as they exist today with suggestions for improving the way in which the models' results are presented to decision makers.

Finally, some improvements are suggested to remedy the observed deficiencies in current estimating techniques.

CATEGORY: 6

NAME: Bibliography for Aircraft Parameter Estimation

ENTRY No(s): 6-05

DESCRIPTION: An extensive bibliography in the field of aircraft parameter estimation has been compiled. This list contains definitive works related to most aircraft parameter estimation approaches. Theoretical studies as well as practical applications are included. Many of these publications are pertinent to subjects peripherally related to parameter estimation, such as aircraft maneuver design or instrumentation considerations.

CATEGORY: 6

NAME: Catalog of Wargaming and Military Simulation Models, 10th edition.

ENTRY No(s): 6-06

DESCRIPTION: This catalog lists the descriptions of more than 600 simulations, war games, exercises, and models in general use throughout the Department of Defense and in the defense establishments of Australia, Canada, England, and Germany.

The entries are listed alphabetically by acronym and long title. A second index categorizes the entries by type and application.

The description of each model includes: proponent, developer, purpose, general description, input, output, limitations, hardware, software, time requirements, security classification of the model (less data), frequency of use, and point of contact for additional information.

The catalog uses inputs from analysis agencies in the various defense establishments, independent contractors and research organizations, and similar catalogs for games and simulations.

The catalog is published by the Office of the Scientific and Technical Advisor, Joint Analysis Directorate, Organization of the Joint Chiefs of Staff. The date of the report is May, 1986.

CATEGORY: 6

NAME: Combined Logistics Model: Concept and Identification Phase

ENTRY No(s): 6-07

DESCRIPTION: Several models are used to assist in formulating overall policy for the USAF logistics system. Among these are life cycle cost models, inventory models, level of repair models, and weapon system operating models.

The systems the models portray are interdependent. However, the models were developed independently and generally do not reflect the interdependency and continuity of the overall logistics process. The grouping of several of these models into a combined logistics system model and application of feedback control theory analysis to it might give Air Force logisticians better insight into the overall logistics life of weapons systems.

This paper does not attempt to answer that question in its totality. The intent of this paper is to lay a foundation for the solution of the problem.

After considering some basic questions concerning a combined logistics system model, the paper attempts the first step in addressing the overall problems. That step will be to identify the logistics systems models which are currently in frequent use within the Air Force and which should be considered for use in a combined logistics system model.

CATEGORY: 6

NAME: A Comparison of Analytic and Simulation Reliability and Maintainability (R/M) Prediction Methods

ENTRY No(s): 6-08

DESCRIPTION: Two methods for predicting the reliability and maintainability (R/M) of systems are discussed, a simulation method and an analytic method. Two computer programs (SIM3 and GEMJR) incorporating these methods and their input and output are described.

The simulation method uses Monte Carlo techniques in predicting reliability. The analytic method incorporates the Poisson failure process to develop stochastic matrices that are solved using infinite series to give reliability and availability.

The advantages and disadvantages of both methods are discussed. System configuration changes and complex missions can be considered more effectively using the simulation method. However, simulation does not calculate availability and provides only approximate results.

In contrast, the analytic method predicts exact results and can examine such maintenance aspects as repairmen, standbys, and redundancies.

Both methods are useful tools depending upon the R/M applications.

CATEGORY: 6

NAME: A Comparison of Capability Assessment using the LOGRAM and DYNA-METRIC Computer Models

ENTRY No(s): 6-09

DESCRIPTION: The LOGRAM model estimates weapon system capability by estimating aircraft availability based on the percentage of wartime spares requirements provided by estimated on-hand assets.

DYNA-METRIC estimates aircraft availability based on the number of FMC aircraft for a given stockage position.

A LOGRAM data base was evaluated using DYNA-METRIC to determine differences in aircraft availability estimates. DYNA-METRIC produced a lower estimate of aircraft availability than did the LOGRAM model.

Research indicated that a mixed model, using LOGRAM to develop the data base and DYNA-METRIC to provide the aircraft availability estimates would provide a blend of the strong points of each model.

Jordan and Associates

AF88-092 Phase I

CATEGORY: 6

NAME: Compendium of Operations Research and Economic Analysis Studies

ENTRY No(s): 6-10

DESCRIPTION: This updated compendium consists of abstracts of published studies completed by the Operations Research and Economic Analysis office of the Defense Logistics Agency and is intended to serve as a reference document for other offices or agencies contemplating similar or related studies.

CATEGORY: 6

NAME: Computer Models used by the Assistant Chief of Staff Studies and Analysis, Headquarters United States Air Force

ENTRY No(s): 6-11

DESCRIPTION: The purpose of this document is to provide a listing of computer simulation models used by Headquarters USAF Studies and Analyses.

The ACOS, Studies and Analyses provides to the Air Force and DOD timely illumination and visibility of the force structure issues which bear on defense posture readiness decisions. Ultimately, illumination of such issues provides the basis for DOD decisions today regarding the allocation of money and other resources for national defense force structures of the future.

Computer simulation modeling is one of the analytical techniques used by the analyst to gain insight into the myriad of detailed relationships effecting force structure and force readiness decisions.

CATEGORY: 6

NAME: Mathematical and Statistical Software Index

ENTRY No(s): 6-13

DESCRIPTION: This paper is an abridged documentation source for the Air Force Human Resources Laboratory (AFHRL) mathematical and statistical software library for use by Air Force researchers. It provides a single reference to identify mathematical or statistical computer software that is currently operational and available for use on the AFHRL Sperry 1100/81 computer system.

The paper is comprised of four chapters:

- Introduction and information
- Descriptions of the library's single function computer programs
- Descriptions of the library's subroutine systems
- Nationally recognized statistical packages available in the software library.

CATEGORY: 6

NAME: Selected Models and Techniques Compiled by HQ
AFSC/ALT

ENTRY No(s): 6-15

DESCRIPTION: This compilation represents the initial effort to provide a consolidated listing of the major logistics analysis models/techniques currently in use by or in conjunction with the Air Force Systems Command. It was prepared from information provided by model developers, using agencies, and current user's guides and model documentation.

The intent is for this information to form the basis for broader use of good models/techniques, and perhaps to help eliminate or initiate major improvement to those which are not being used.

CATEGORY: 6

NAME: Study of Unclassified DOD Owned or Public Domain Computer Games and Simulations and Their Applicability to the ACSC Associate Programs Seminar Curriculum

ENTRY No(s): 6-16

DESCRIPTION: The purpose of this study was to identify and describe Air Force owned games and simulations and to determine if they can be used to enhance the Air Command and Staff College (ACSC) Associate Programs seminar Curriculum.

The author categorized the identified games by subject area and produced a one page description for each of the thirty-nine identified games. The author concluded that nine of the thirty-nine games could be quickly adapted for use by the ACSC Associate Programs seminar students with little or no modification. In addition, another twenty-five games probably could be adapted for use after significant modifications.

CATEGORY: 6

NAME: Survey of Models/Simulation at RADC

ENTRY No(s): 6-17

DESCRIPTION: A survey was conducted to evaluate the current state-of-the-art and technology of model/simulation capabilities at the Rome Air Development Center, Griffiss AFB, NY and Hanscom AFB, MA. This report presents a tabulation of 60 such models and simulations.

A questionnaire focused upon the identification of the models and simulations used by RADC engineers in the development and evaluation of command, control, communications, and intelligence (C3I) concepts, designs, and systems. Additional technical information regarding hardware/software operation, interface, limitations/assumptions, documentation and status was also solicited in an attempt to provide a brief but comprehensive description of the model/simulation.

The office of primary responsibility for each model or simulation along with the responsible person and corresponding telephone numbers are provided if additional information is desired by the reader.

CATEGORY: 6

NAME: Theater Simulation of Airbase Resources and
Logistics Composit Models: A Comparison

ENTRY No(s): 6-20

DESCRIPTION: The purpose of this study was to determine if, given similar data bases, the Theater Simulation of Airbase Resource (TSAR) model could duplicate the results of the Logistics Composite model (LCOM).

To make this determination the models were compared on the basis of two outputs: manhours per sortie and sorties flown. The models were provided common data bases having similar tasks, probabilities, and sequences; resource requirements; and sortie requests. Each model was run for ten replications at three different levels of requested flying activity. These levels represented daily sortie rates of 1.0, 2.0, and 3.0 sorties per aircraft per day.

The manhours per sortie expended by the individual Air Force Specialty Codes represented in the data bases, and the number of sorties flown, were gathered for each replication and level. The manhours per sortie were compared on both a statistical and practical basis. The results of this comparison concluded that no significant difference existed between the two models.

The sorties flown by the models were statistically compared at each of the three levels of requested flying activity. The results showed that a significant statistical difference existed between the output sorties flown in the two models.

CATEGORY: 6

NAME: A Trade-Off Study of TILT Rotor Aircraft versus
Helicopters using VASCOMP II and HESCOMP

ENTRY No(s): 6-22

DESCRIPTION: Trade-off studies were conducted in which two versions of tilt rotor aircraft were examined to determine optimum mission distances where the tilt rotor designs were superior to a comparable contemporary (pure) helicopter.

Two Fortran computer programs (VASCOMP II and HESCOMP) developed under contract for NASA Ames Research Center by the Boeing VERTOL Company were used to predict aircraft performance. Program results were validated using data from independent sources.

A simplified user's manual is included (with sample data and program output) for VASCOMP II, use at the Naval Postgraduate School, Monterey, California.

CATEGORY: 6

NAME: TSAR/DYNA-METRIC Comparison

ENTRY No(s): 6-23

DESCRIPTION: The Theatre Simulation of Airbase Resources (TSAR) model and the DYNA-METRIC model are two large capability assessment models, both of which were developed by the RAND Corporation.

Although primarily designed to model two different things, the question is often asked, 'Given similar scenarios, do the models produce similar or near similar results?' This study was designed to answer that question.

Given similar scenarios, the two models do not always yield the same results.

CATEGORY: 6

NAME: Two Models for Optimal Allocation of Aircraft Sorties

ENTRY No(s): 6-24

DESCRIPTION: This paper presents two models for allocating general purpose aircraft to missions in a multi-period war. The models are two-person, zero-sum, sequential games with simultaneous moves each period. Ground forces as well as air forces are included. Three measures of effectiveness are available.

The paper evaluates a game allowing non-adaptive strategies and a game allowing behavioral strategies. It is shown that the latter game is equivalent to a game allowing the larger class of adaptive strategies.

At each subperiod a fractional allocation of aircraft to missions is input to the assessment procedure. Also input are time-varying numbers of divisions and aircraft and the fixed number of aircraft shelters. The final input is the fixed set of effectiveness parameters consisting of firepower per division, firepower per combat air support sortie, probability of detection and kill of attack and defense aircraft in the intercept interaction, probability of detection and kill of sheltered and non-sheltered aircraft in the airbase attack interaction, FEBA advance as a function of force ratio, and divisional casualties as a function of force ratio.

Output data consists of the total number of aircraft killed (by type), as well as cumulative total firepower, air firepower, and ground casualties from firepower ratios.

SECTION 3
DEVELOPER/SPONSOR LIST

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>
APS	Applied Psychological Services, Inc.
ARC	Aerophysics Research Corporation Bellevue, WA
ARINC	ARINC Research Corporation
ARL	Aeronautical Research Labs GPO Box 4331 Melbourne, VIC 3001 Australia
ARPC	Applications Research Corporation Dayton, OH
A. T. Kearney	A. T. Kearney, Inc. Caywood-Schiller Division 100 S. Wacker Drive Chicago, Ill 60606

A

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	
BATTELLE	BATTELLE Columbus Division 505 King Avenue Columbus, OH 43201-2693	B
BDM	BDM Corporation 7915 Jones Branch Drive McLean, VA 22101-3396	
Boeing	The Boeing Company P. O. Box 3707 Seattle, WA 98124-2207	
-MASD	Military Airplane Systems Division Seattle, WA 98124-5000	
-VERTOL	Boeing-VERTOL Company P. O. Box 16858 Philadelphia, PA 19142-0858	
BRL	Ballistic Research Laboratory Aberdeen Proving Ground, MD 21005-5066	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	C
CACI	CACI, Inc. 1815 North Fort Meyer Drive Arlington, VA 22209-0268	
CALSPAN	CALSPAN Corporation Buffalo, NY	
CNA	Center for Naval Analysis Box 16268, 4401 Ford Ave Alexandria, VA 22302-0268	
COBRO	COBRO Corporation 1400 Spring Street, Suite 216 Silver Spring, MD 20910-5000	
COMARCO	COMARCO, Inc. 150 West Cerritos Anaheim, CA 92805	
CSC	Computer Sciences Corporation Hampton, VA	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>
DOD	Department of Defense Washington, D.C.
DOD/CAIG	Cost Analysis Group
DOD/CINCPAC	U. S. Commander-in-Chief, Pacific Research and Analysis Division Camp H. M. Smith, HI 96861
DOD/DLA	Defense Logistics Agency
DOD/DNA	Defense Nuclear Agency
DOD/DARPA	Director of Defense Research and Engineering Advanced Research Project Agency Arlington, VA 22209
DOD/JCS-JAD	Joint Analysis Directorate Organization of the Joint Chiefs of Staff The Pentagon, Washington, D. C. 20301
DOD/JDSSC	Joint Data Systems Support Center
DOD/LOGINST	OASD/P&L Logistics Institute The Pentagon, Room 3D139
DOD/OSN	Office of the Secretary of the Navy
DOD/PA&E	Program Analysis & Evaluation

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>
DOD/WESEG	Director of Defense Research and Engineering Weapons System Evaluation Group 400 Army-Navy Drive Arlington, VA 22202-5000
DRC	Dynamics Research Corporation 60 Concord Street Wilmington, MA 01887
DSA	Decision Science Applications, Inc. Arlington, VA

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	<u>E-F</u>
FAA	Department of Transportation Federal Aviation Administration 800 Independence Avenue Washington, DC 20553-5000	
-PEMS	Program Engineering and Maintenance Service	
-SRDS	Systems Research and Development Service	
-TECH	FAA Technical Center Atlantic City Airport, NJ 08405-5000	
Falcon	Falcon Research and Development Co. 696 Fairmont Ave Baltimore, MD 21204	
FSI	Flight Systems Incorporated 1901 Dove Street P. O. Box 2400 Newport Beach, CA 92660	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	G-H
GD	General Dynamics Corporation	
-Fort Worth	Fort Worth Division P. O. Box 748 Fort Worth, TX 76101-9990	
-Western	Western Data Systems Center P. O. Box 80847 San Diego, CA 92138-5000	
-Convair	Convair Division San Diego, CA	
GE	General Electric Company Aircraft Equipment Division Burlington, VT	
GRC	General Research Corporation	
Grumman	Grumman Aerospace Corporation Bethpage, NY 11714-3586	
Honeywell	Honeywell Corporation, Aerospace Division St. Petersburg, FL 33733-5000	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	
		I-J-K
IDA	Institute for Defense Analysis 1801 North Beauregard Street Alexandria, VA 22311-1772	
ISI	Information Spectrum, Inc. 1745 S. Jefferson Highway Arlington, VA 22202	
ITT	ITT/Avionics Division	
JPL	Jet Propulsion Lab Pasadena, CA	
KAMAN	KAMAN Aerospace Corporation Old Winsor Road Bloomfield, CT 06002-5000	
-Avidyne	Avidyne Division Burlington, MA 01803-5000	
-Sciences	KAMAN Sciences Corporation 1911 S. Jefferson Davis Hwy, Suite 1200 Arlington, VA 22202-5000	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>
LMI	Logistics Management Institute 6400 Goldsboro Road Bethesda, MD 20817-5886
Lockheed	Lockheed Corporation
-AERO	Aeronautical Systems Company P. O. Box 551 Burbank, CA 91520-8240
-CALIF	Lockheed California Company Burbank, CA 91520
-MSC	Lockheed Missiles and Space Co., Inc. 1111 Lockheed Way Sunnyvale, CA 94088
Los Alamos	Los Alamos National Lab Los Alamos, NM 87545
LTV/Vought	LTV Aerospace Corporation
-AERO	Vought Aeronautics & Products Division 9314 West Jefferson P. O. Box 225907 Dallas, TX 95265-5000
-ASTRO	Vought Astronautic Company

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	M
MD	McDonnell-Douglas Corporation St. Louis, MO 63166-5000	
-Douglas	Douglas Aircraft Company Long Beach, CA	
-ASTRO	Astronautics Company - East P. O. Box 516 St. Louis, MD 63166-5000	
MM	Martin Marietta Corporation Baltimore, MD	
MRC	Mission Research Corporation P. O. Drawer 719 Santa Barbara, CA 93102-5000	
MITRE	The MITRE Corporation Box 208 Bedford, MA 01730-5000	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	<u>N</u>
NAG/ARD	NATO Advisory Group Aerospace Research and Development 7 Rue Ancelle Neuilly-Sur-Seine, France	
NASA	National Aeronautics and Space Administration Washington, DC 20546	
-AMES	AMES Research Center Moffett Field, CA 94035	
-LRC	Langley Research Center	
Northrop	Northrop Corporation Century City, LA	
-AC	Aircraft Division One Northrop Avenue Hawthorne, CA 90250-3277	
-EL	Electronics Division Research Plaza Palos Verdes, CA 90274-5000	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	<u>O-P-Q</u>
ORINC	Operations Research, Inc. Silver Spring, MD	
OTI	Orlando Technology, Inc. P. O. Box 855 Shalimar, FL 32579-5000	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	R
RAE	Royal Aircraft Establishment Farnborough, Hants England, UK	
RAIL	RAIL Company Executive Plaza III Hunt Valley, MD 21031-5000	
RAND	RAND Corporation 1700 Main Street P. O. Box 2138 Santa Monica, CA 90406-2138	
Raytheon	Raytheon Company	
RCA	RCA Corporation Government & Commercial Systems Aerospace Systems Division Burlington, MA 01803-5000	
Rockwell	Rockwell International Corporation	
-LA	Los Angeles Division 5601 W. Imperial Highway Los Angeles, CA 90009-5000	
-AN	Anaheim Division 3370 Miraloma Avenue Anaheim, CA 92803-4921	
RR	Riverside Research	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	S
SAI	Science Applications International Corporation 8400 Westpark Drive McLean, VA 22102-1303	
SANDIA	SANDIA Labs Albuquerque, NM	
SHAPE	SHAPE Technical Center P. O. Box 174 The Hague, The Netherlands	
Sikorsky	United Technologies Corporation Sikorsky Aircraft Division North Main Street Stratford, CT 06601-1381	
SOFTECH	SOFTECH, Inc. 2000 N. Beauregard Street Alexandria, VA 22311	
SRI	Stanford Research Institute Palo Alto, CA	
STI	Systems Technology, Inc. 13766 South Hawthorne Blvd. Hawthorne, CA 90250	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>
TASC	The Analytical Sciences Corporation 6 Jacob Way Reading, MA 01867-3991
TECHINC	Technology Incorporated P. O. Box 3036 Overlook Branch Dayton, OH 45431-5000
Technion	Israel Institute of Technology Department of Aeronautical Engineering Haifa, Israel
Titan	Titan Systems Inc. 187 E. Wilber Rd, Suite 12 Thousand Oaks, CA 91360

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	<u>U</u>
U/AS	Arizona State University Tempe, AZ 85281-5000	
U/CALBERK	University of California Berkley, CA	
U/CLEM	Clemson University Clemson, SC 29634-1907	
U/COR	Cornell University Ithaca, NY 14853-5301	
U/FIT	Florida Institute of Technology Fort Lee, VA 23801-5000	
U/GIT	Georgia Institute of Technology Atlanta, GA	
U/GW	George Washington University Washington, DC 20037-2526	
U/ICST	Imperial College of Science and Technology London, England, UK	
U/KS	Kansas State University Manhattan, KD 66506-5000	
U/LT	Louisiana Tech University Ruston, LA 71270	
U/MIT	Massachusetts Institute of Technology Cambridge, MA 02139-5000	
U/NC	University of North Carolina Chapel Hill, NC 27514-5000	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	U
U/OKLA	University of Oklahoma Norman, OK 73019-5000	
U/OKS	Oklahoma State University Stillwater, OK 74074-5000	
U/VPI	Virginia Polytechnic Institute and State University Blacksburg, VA 24061-5000	
U/WASH	University of Washington Seattle, WA 98105-5000	
U/WS	Wright State University Dayton, OH 45431-5000	
UESI	University Energy Systems, Inc. 4401 Dayton-Xenia Road Dayton, OH 45432-1894	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	U
USA	United States Army	
USA/ADS	Air Defense School Fort Bliss, TX	
USA/AMCC	Armament, Munitions & Chemical Command Rock Island, Ill 61299-6000	
-OCS	Ordnance Center and School Aberdeen Proving Ground	
USA/ASC	Aviation System Command 4300 Goodfellow Blvd St. Louis, MO 63120-1798	
-RTL	Applied Technology Laboratory Research & Technology Lab Fort Eustis, VA 23604-5577	
-ARTA	Aviation Research and Technology Activity Moffett Field, CA 94035-5000	
-MRDL	Mobility Research and Development Laboratory Fort Eustis, VA 23604	
USA/CAA	Concepts Analysis Agency 8120 Woodmont Avenue Bethesda, MD 20814-2797	
USA/CACDA	Combined Arms Combat Development Activity Fort Leavenworth, KS 66027-5130	
USA/DCOS-LOG	Deputy Chief of Staff, Logistics	
USA/LC	Logistics Center	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	<u>U</u>
USA/MATC	Material Command 5001 Eisenhower Avenue Alexandria, VA 22333-0001	
-SAA	Systems Analysis Activity Aberdeen Proving Ground, MD 21005-5071	
-SAP	Systems Analysis Activity U.S. Customs House, Room 800 Philadelphia, PA 19106-2976	
-SEL	School of Engineering and Logistics Red River Depot	
-SMT	Supply, Maintenance, and Transportation	
USA/MC	Missile Command Redstone Arsenal, AL 35898-5000	
USA/MD	Management Directorate	
USA/MSSA	Management Systems Support Agency	
USA/OTEA	Operational Test & Evaluation Agency 5600 Columbia Pike Falls Church, VA 22041-5115	
USA/RI	Research Institute for The Behavioral and Social Sciences 5001 Eisenhower Avenue Alexandria, VA 22333-5600	
USA/TRADOC	Training and Doctrine Command Fort Monroe, VA 23651-5000	
-SA	Systems Analysis Activity White Sands Missile Range, NM 88002-5057	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	<u>U</u>
USAF	United States Air Force	
USAF/AAMRL	Harry G. Armstrong Aerospace Medical Research Laboratory	
USAF/ACOS-SA	Assistant Chief of Staff Studies and Analysis The Pentagon, Room 1C370 Washington, DC 20330-5420	
USAF/ACSC	Air Command and Staff College	
USAF/AFA	Air Force Academy Colorado Springs, CO 80840-5981	
USAF/AFIT	Air Force Institute of Technology Wright-Patterson AFB, OH 45433-6583	
USAF/AFLC	Air Force Logistics Command Wright-Patterson AFB, OH	
-ALCN	Air Logistics Center, San Antonio	
-ALCO	Air Logistics Center, Ogden	
-ALCS	Air Logistics Center, Sacramento	
-ALD	Acquisition Logistics Division	
-LMC	Logistics Management Center Gunter AFB	
-MM	Deputy Chief of Staff Material Management	
-MS	Deputy Chief of Staff Management Sciences	
-P&P	Deputy Chief of Staff Plans & Programs	

Developer/Sponsor List

Acronym	Title and Address	U
USAF/AFSC	Air Force Systems Command Wright-Patterson AFB, OH	
-ADTC	Armament Development Test Center Eglin AFB, FL 32542	
-AL	Armament Laboratory Eglin AFB, FL 32542	
-ASD	Advanced Systems Division	
-ESD	Electronics Systems Division Hanscom AFB, MA 01731-5000	
-HRLB	Human Resources Laboratory Brooks AFB, TX 78235-5000	
-HRLW	Human Resources Laboratory Wright-Patterson AFB, OH	
-TAWC	Tactical Air Warfare Center Eglin AFB, FL 32542	
USAF/AFWAL	Air Force Wright Aeronautical Labs Wright-Patterson AFB, OH 45433	
-AL	Avionics Laboratory	
-APL	Aero Propulsion Laboratory	
-FDL	Flight Dynamics Laboratory	
-FIAA	FDL Analysis Branch	
-FIAC	FDL Concepts Branch	
USAF/DCOS-RD&A	Deputy Chief of Staff Research, Development and Acquisition Washington, DC 20330-5000	
USAF/DCOS-S&L	Deputy Chief of Staff Supply & Logistics Washington, DC 20330-5000	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	<u>U</u>
USAF/ESC	Engineering and Services Center Tyndall AFB, FL 32403-6001	
USAF/ETAC	Environmental Technical Applications Ctr. Scott AFB, Ill 62225-5000	
USAF/OSR	Office of Scientific Research Bolling AFB Washington, DC 20332-6448	
USAF/PACAF	Commander-in-Chief Pacific Air Forces	
USAF/RADC	Rome Air Development Center Griffiss AFB, NY 13441	
USAF/TAC	TAC Liaison Office Fort Leavenworth, KS 66027	
USAF/TEC	Test and Evaluation Center Kirtland AFB, NM 87117-5000	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	<u>U</u>
USN	United States Navy	
USN/CMC	Commandant of The Marine Corps	
USN/CNO	Office of the Chief of Naval Operations	
USN/FMSO	Navy Fleet Material Supply Office P. O. Box 2010 Mechanicsburg, PA 17055-0787	
USN/NADC	Naval Air Development Center Warminster, PA 18974-5000	
USN/NASC	Naval Air Systems Command Washington, DC 20361-2000	
USN/NATC	Naval Air Test Center NAS Patuxent River, MD	
USN/NPS	US Naval Postgraduate School Monterey, CA 93943-5100	
USN/NTEC	Naval Training Equipment Center Orlando, FL 32813	
USN/NWC	Naval Weapons Center China Lake, CA 93555-6001	
USN/ONAS	Office of Naval Acquisition Support	
USN/ONR	Office of Naval Research 800 N. Quincy St. Arlington, VA 22217-0001	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	<u>U</u>
USN/SRDC	Ship Research and Development Center Bethesda, MD 20084-5000	
USN/SSC	Naval Supply Systems Command	
-NALC	Naval Aviation Logistics Center NAS Patuxent River, MD	
-NASO	Naval Aviation Supply Office	
USN/WC	Naval War College Newport, RI 02841-5010	
USN/WESA	Weapons Engineering Support Activity Navy Yard, Washington, DC 20374-2202	
USN/WSAO	Weapons Systems Analysis Office Navy Yard, Washington, DC 20374	

Developer/Sponsor List

<u>Acronym</u>	<u>Title and Address</u>	<u>V-W-X-Y-Z</u>
Vector	Vector Research P. O. Box 1506 Ann Arbor, MI 48106	
VEDA	VEDA, Inc. San Diego, CA	
XMCO	XMCO, Inc. Reston, VA	
XYZYX	XYZYX Information Corporation 21116 Van Owen Street Canoga Park, CA 91303	